OLUME 15 1939 JUL 24 19 NUMBER 3

ECONOMIC GEOGRAPHY

PERIODICAL ROOM GENERAL LIBRARY UNIV. OF MICH.

JULY

AGRICULTURE IN FINLAND
William R. Mead

STUDIES OF RIVER DEVELOPMENT IN THE KNOXVILLE-CHATTANOOGA AREA
G. Donald Hudson, Aelred J. Gray, Harold V. Miller, Robert M. Howes, Edward N. Torbert, Christian C. Crossman, and Victor Roterus

WATER IN THE LARAMIE REGION OF WYOMING
Carol Y. Mason

CHEESE REGION OF SOUTHEASTERN WISCONSIN
Loyal Durand Jr.

LAND UTILIZATION OF THE UNIVERSITY LAKE DRAINAGE BASIN
F. C. Erickson and W. H. Levitt

THE SOYA BEAN IN MANCHURIA
G. F. Deasy

DISTRIBUTION OF SUGAR CANE PRODUCTION IN CUBA
Helen M. Boyer

ARK UNIVERSITY, WORCESTER, MASSACHUSETTS, U.S.A.

OUR CONTRIBUTORS

Mr. Mead, a member of the Anglo-Finnish Society, has traveled in Finland and has written several articles on that country. He is engaged in graduate study in economic geography at the London School of Economics and Political Science. At present he is touring Scandinavia studying geographic and economic conditions there. The first instalment of his article appeared in the April issue.

Dr. Hudson, chief of the Land Planning Division, came to the Tennessee Valley Authority in 1934 as the first geographer on the TVA staff. He has written extensively in his field, a number of his articles appearing in ECONOMIC GEOGRAPHY. Recently his appointment as professor of geography at Northwestern University has been announced.

Mr. Gray, assistant geographer, who came to the TVA in 1935, has been active in the Valley-wide land classification survey and the solution of such problems as rural zoning, social and economic effects of reservoir construction, and the appraisal of land resources.

Mr. Miller, assistant geographer in the Land Planning Division of the TVA, has been active in the Valley-wide classification survey conducted by the Division, and has been largely responsible for its work in trade areas. He has been on the staff of TVA since 1934.

Mr. Howes, associate regional planner, also joined the TVA staff in 1934. Since his appointment, his major activities have been concerned with recreational land-use planning, including planning work for properties relating to reservoirs, as well as to a Valley-wide inventory of scenic and recreational resources.

Dr. Torbert, associate geographer, with the Authority since 1935, is currently on loan to the National Resources Committee, devoting himself to a coöperative study of land utilization, migration, and settlement in the Pacific Northwest.

Mr. Crossman, assistant geographer in the Land Planning Division of the TVA, has been chiefly concerned with land and land-use studies in areas related to TVA reservoirs and the development of land-use plans for reservoir properties. He came to TVA in 1934.

Mr. Roterus, associate geographer connected with the TVA since 1935, has engaged principally in special regional and related manufacturing studies. Prior to his coming to the TVA, Mr. Roterus was for four years instructor in the School of Business Administration at Washington State College, Pullman, Washington.

Dr. Mason received her M.A. and Ph.D. degrees at Clark University. Formerly assistant professor of geology and geography at Milwaukee-Downer College, she is now professor of geography at Northwest Missouri State Teachers College, Maryville, Missouri. She has long been a valued contributor to ECONOMIC GEOGRAPHY.

Mr. Durand is assistant professor of geography at the University of Wisconsin. His major regional field of interest is the study of dairy regions, and the state of Wisconsin. He is co-author with Whitbeck and Whitaker of *The Working World*, and has contributed the chapter on state planning to the Parkins and Whitaker *Conservation of Natural Resources.*

Dr. Erickson now on the staff of the University of North Carolina, has written before for ECONOMIC GEOGRAPHY, his article *Transhumance in Schächenthal* appearing in the issue of January 1938. His major interest is land utilization.

Mr. Levitt is also on the staff of the University of North Carolina, having received his A.M. in sociology from the Institute for Research in Social Sciences.

Mr. Deasy, instructor in geography at the University of Cincinnati since 1936 when he received his A.M. from that institution has to his credit a number of articles in the general field of geography, including an earlier contribution on Manchuria, one of his special fields of interest.

Miss Boyer received her A.M. degree in geography from Clark University in 1938, having completed special research in the subject of Cuban sugar production, under the direction of Dr. Clarence F. Jones. Her major interest lies in the field of economic geography.

Copyright 1939
by Clark University, Worcester, Massachusetts

(Indexes of ECONOMIC GEOGRAPHY *are issued every October for the volume just completed. The articles of the magazine are also indexed in the International Index to Periodicals to be found in every United States Library.)*

Subscribers are requested to send notices of change of address five weeks before they are to take effect. Failure to send such notice will result in the incorrect forwarding of the next copy and delay in its receipt. Old and new addresses must also be given.

ECONOMIC GEOGRAPHY

CONTENTS FOR JULY, 1939

AGRICULTURE IN FINLAND. PART II 217
WILLIAM R. MEAD

STUDIES OF RIVER DEVELOPMENT IN THE KNOXVILLE-CHATTANOOGA AREA . 235
G. DONALD HUDSON, AELRED J. GRAY, HAROLD V. MILLER, ROBERT M. HOWES, EDWARD N. TORBERT, CHRISTIAN C. CROSSMAN, AND VICTOR ROTERUS

WATER IN THE LARAMIE REGION OF WYOMING 271
CAROL Y. MASON

CHEESE REGION OF SOUTHEASTERN WISCONSIN 283
LOYAL DURAND, JR.

LAND UTILIZATION OF THE UNIVERSITY LAKE DRAINAGE BASIN 293
F. C. ERICKSON AND W. H. LEVITT

THE SOYA BEAN IN MANCHURIA 303
G. F. DEASY

DISTRIBUTION OF SUGAR CANE PRODUCTION IN CUBA 311
HELEN M. BOYER

ECONOMIC GEOGRAPHY

Published Quarterly by

CLARK UNIVERSITY, at 44 Portland Street, Worcester, Mass.

Editorial Office, Clark University, Worcester, Massachusetts

PRICE, $1.50 THE CURRENT NUMBER

FIVE DOLLARS A YEAR
(except to charter subscribers)

Entered as second class matter at the Post Office at Worcester, Mass., under the Act of August 24, 1912

Copyright, 1939
by
Clark University
Worcester, Massachusetts

DROUGHT

DROUGHT makes of half the world, almost, essentially a desert. Some lands suffer drought year in, year out; some lands are regularly dry for part of the year; some lands are intermittently subject to drought every year; some lands are dry only at rare intervals, periodic or accidental. Some lands suffer intense drought, they are parched deep and continually; some lands are desiccated only fitfully and not severely; some lands feel the tragedy of drought so lightly as never really to suffer.

For drought is merely relative. Few indeed are the places of the earth where rain never comes, where there is no water. Complete desiccation is a rare phenomenon. Some kind of plant life grows almost everywhere. Some moisture is nearly everywhere obtainable. But drought in any degree is likely to result in tragedy.

When plants cannot find water to grow and ripen their fruit, man cannot find food. When springs dry up, man thirsts to death. Where there are no rivers there can be no industries, no water travel. Where rain never comes there is dust, and dirt, and desolation, and there drought calamitously reigns. Drought, like flood and earthquake and pestilence, works havoc. There is no relief from drought.

ECONOMIC GEOGRAPHY

VOL. 15 JULY, 1939 NO. 3

AGRICULTURE IN FINLAND

William R. Mead

PART II

(First instalment appeared in the April 1939 issue)

HAVING considered briefly the purely geographic background to Finnish agriculture, the economic factors affecting the form of cultivation may now be considered. As a region transitional between oceanic and continental Europe and at the same time intermediate between the European plain and the tundra, Finland offers a unique example of the response of agriculture to its geographic background.

ECONOMIC ELEMENTS

In the first place, Finland lies upon the margin of crop cultivation in Europe. Within its confines are crowded the absolute limits of growth of a number of individual plants (Figure 8). From the viewpoint of economic geography, however, except where domestic self-sufficiency is the prime consideration, the economic limit of production is of greater consequence. The spread of communications throughout the northern part of the country automatically reduces the isolated self-sufficing farmstead to a position of greater safety and dependence. Even the Lapp agriculturalist no longer attempts crop production upon the absolute confines, to the extent which was formerly evident.

The economic limit of crop cultivation is a limit which is variable according to a number of factors. In the first place it is variable in relation to anticipated price. Expansion or contraction of the area devoted to one crop at the expense of another will be a response to differential price movements. If there is a general advance in agricultural prices, the result may be an absolute expansion of cultivated area. This applies not only to the land surface under cultivation upon the individual farmstead, it also has reference to introduction of certain crops outside the pre-existing geographic limit. In other words, the chance of gain from an introduction of crops hitherto avoided outweighs the risk of loss.

In the second place, the economic limit of crop cultivation can be extended through modifications in the nature of the crop, *per se*. In the case of cereals, quicker ripening varieties enable cultivation to push beyond former limits of cultivation; while drought resisting and frost resisting species enable an expansion of the economic boundary. The significance of the economic limit of agricultural production in Finland is greater than in most countries because the climatic regime introduces a rigid

restriction upon the range of products which can be grown and the nature of the soils imposes narrow limits upon extent of cultivation. Many difficulties of Finnish agriculture spring from problems of alternative production. As a result of relative uniformity of geographic conditions in the south and the unproductive northern wastes, there can be no interchange of complementary products between regions of varying agricultural productivity in Finland.

FIGURE 7.—A small estate at Lohja, Southwest Finland, illustrating location of settlement upon a southern slope. Variety of crops—hay in the foreground, rye and barley, and an intensively tilled kitchen garden (complete with a greenhouse)—gives a general air of prosperity. The estate contrasts with the smaller peasant farmstead in Pohjanmaa (Figure 11). (Courtesy of The Finnish Legation.)

Except in the southwest, where ameliorations of a more temperate climate permit production of greater variety of crops, agricultural production is stamped with roughly the same pattern and the yield of any two farms in any two given regions, though showing deviations in respect of quality and quantity, will bear approximately the same complection. The number of alternative crops which the farmer can produce is limited. In so far as his activities are not disturbed by profound economic influences from external sources, his output is largely similar. If, however, changing price structure calls for modification, he feels the pinch of climate, for the capacity for substitution of alternative products is small.

Neither is crop limitation alone influential. Animal husbandry is also restricted. Sheep, for example, both as a result of severity of winter and deficiency of natural pastures (especially of hilly pastures) are present only in small numbers. There are little more than half a million sheep in Finland, i.e., less than half the number of cattle. The reindeer offsets in some measure the paucity of sheep and prospects of increasing herds which frequent the tundras suggest a favorable future for this industry.

SOCIAL FACTORS

If the fundamental factors in deciding the relationship between the farmer in Finland and the form of his activity are climatic and edaphic, social factors occupy a secondary place of no mean consequence. The system of farming in Finland has done much to promote the present energy exerted in the field of agriculture and to decide the economics

of activity. Post-war agrarian reform modified the system of land holding and by accelerating the trend towards ownership and away from tenancy encouraged a stable rural population. The rapid evolution of the country from a nation where the large estate was dominant to a nation of smallholders had a great vivifying effect upon "the mother industry."

Yet it must not be supposed that necessity for land reform in Finland was as urgent as that within the other states of eastern Europe. The estates had introduced agricultural ameliorations in the pre-war period and progressive land owners had in many areas instituted model farms. The agrarian reform, by creating a regime of the *petit proprietaire*, encouraged new initiative without destroying the seeds of progress which had been sown by the preceding system. Coöperative societies, which came into their own with the winning of Finnish autonomy, continued the pursuit of agricultural improvement and through financial assistance and education encouraged the newly settled farmer owners.

The "democratization" of the countryside gave to a large section of the rural population a new independence, and in Finland there is a real example of the dictum of Arthur Young that "the magic of property turns sand into gold." By the post-war agrarian reform the number of rural landowners was doubled. Yet this rapid evolutionary process was not accomplished without certain difficulties. There was complete lack of capital for provision of those requisites and amenities necessary for promoting continued constructive development.

Even today, agriculture continues to labor under the burden of inadequate capital resources. The smallholder system is well calculated to produce a maximum of efficiency per individual holding; but this maximum is low, where labor is unassisted by the perquisites which guarantee satisfactory returns. Credit banks have done much to facilitate purchase, and the complex of agrarian coöperative societies has assisted individuals in many directions. Introduction of agricultural machinery has been made possible by joint endeavor: drainage schemes are assisted by the state; purchase of produce and

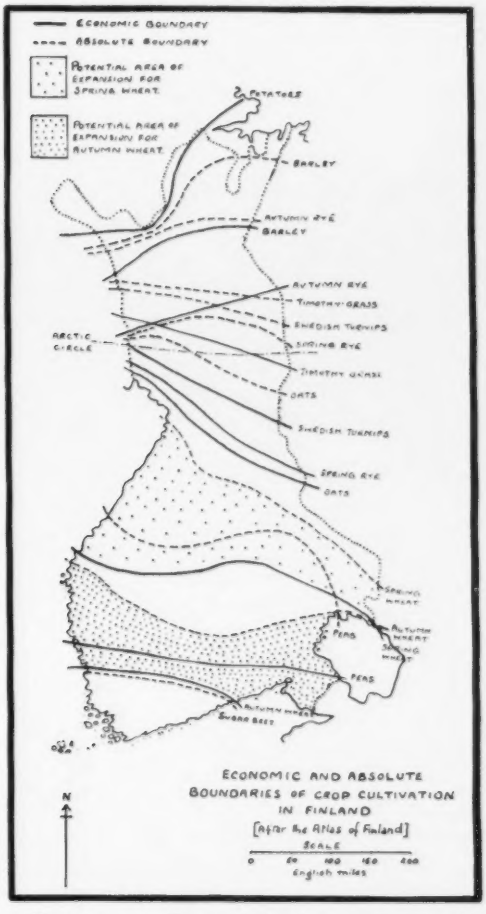


FIGURE 8.—The distinction between the economic and absolute limitation of crop cultivation is manifested in this diagram. The continual retracing of these geographic barriers is illustrative of a new form of coöperation between human agent and the background against which his activities are set. It may therefore be postulated that the stippled regions between any two given margins represent potential cultivable areas for the individual crop considered.

its sale to consumers is undertaken by coöperatives.

The equality in the fortunes of the majority of farmers has encouraged spread of coöperation and at the same time uniform development of farmsteads in the more thickly populated rural areas. The automatic result of the reform act was also to diminish the demand for hired labor. Only where the farm is in excess of thirty hectares is outside labor needed and, even then, chances are that the fortunate possessor of the larger estate will be able to afford some simple mechanism which dispenses with hired labor. A glance at the balance sheet of the average Finnish farmer as set out below illustrates this point. (See Table I.)

While the reform act applied principally to the southwest, independent initiative has always been largely responsible for opening up lands of the interior. Expansion into more remote parts of the lake plateau—into the truly colonial areas of Finland—is very slow and is encouraged by state assistance. The network of communications which ramifies in the southwest and makes agriculture a compact whole, thins out in the lake plateau, and the farmstead becomes an isolated unit, or at most one of a small hamlet which clusters upon the hill slope.

Proximity to the coast and to the main centers of urban settlement unites the agriculture of the coastal plain with overseas regions and with the industry of the town. More than 23 per cent of the total superficial area of Nyland is cultivated: 21.6 per cent of Abo Bjornborg region, and 15.7 per cent of Tavastland. Cultivated land diminishes progressively to the northeast. In the lake province of Kuopio 5.0 per cent of the superficial area is modified by man; in

TABLE I

BALANCE SHEET OF THE AVERAGE FINNISH FARMER
RETURNS AND EXPENSES AS A PER CENT

1936

Returns

Item	*–9 ha.*	*10–24 ha.*	*25–49 ha.*	*50–99 ha.*	*100– ha.*	*Average*
Stock Rearing	8.1	8.0	6.1	4.9	5.1	6.4
Dairy Produce	44.8	50.3	51.6	51.5	50.3	50.7
Horses	.7	1.6	1.3	0.7	0.4	1.1
Pigs	9.8	10.7	8.9	10.0	9.2	9.8
Poultry	16.4	7.2	5.6	6.6	5.4	6.9
Other Domestic Animals	1.1	.7	.4	.2	.1	.4
Agricultural Products	13.4	15.7	24.4	24.9	29.1	22.7
Garden Produce	3.6	1.6	.9	.7	.3	1.1
Fisheries	.7	.3	.1	.01	0	.2
Other Revenue	1.4	.9	.7	.5	.1	.7

Expenses

Stock Rearing	1.9	2.1	1.6	1.3	1.2	1.6
Horses	1.0	1.1	.9	.7	.8	.9
Artificial Fodder	33.7	25.4	27.0	23.4	19.4	23.7
Other Fodder	5.0	3.4	3.0	3.5	5.4	3.6
Manures	12.6	13.5	13.7	12.5	16.6	13.5
Seed Grains	5.0	5.4	4.2	3.9	2.2	4.3
Buildings	4.2	4.3	4.5	3.8	3.8	4.2
Past Debts	5.5	5.6	5.4	4.8	4.6	5.2
Gardens	.6	.3	.2	.3	.2	.3
Wages	18.8	28.5	35.2	36.6	37.4	33.1
Insurance Premiums	2.3	2.1	1.8	1.5	1.1	1.8
Other Expenses	9.4	8.3	7.5	7.7	7.4	7.8

(From Annual Statistics of Finland 1937)

Oulu only one per cent. The degree to which the individual farmer depends upon the direct returns of his land for his foodstuff changes from southwest to northeast. There is a recrudescence of farming upon the basis of relative self-sufficiency away from the fertile coastal plain.

Agricultural method changes also under stress of local conditions. The soil of the southwest and of the marginal plains as a whole permits the use of machinery, where capital makes this possible. Towards the interior, there is a gradual transition through the horse drawn plough to primitive hand digging. Virgin soil consists more generally of boulders than of clods. The changing standard of cultivation from southwest to northeast is accompanied by a changing standard of living.

FIGURE 9.—Farmstead in western Finland. The cluster of buildings which forms such an important part of the capital outlay are evident in this illustration. Simple agricultural machinery is used in reaping a dual harvest which displays an abundance of the ubiquitous cornflowers. (Courtesy of The Finnish Legation.)

With respect to the actual form of farming, there has, in no part of Finland been a complete reversion from subsistence farming to agricultural cropping, i.e. from a form of agricultural practice wherein produce is the source of life to one where profit is the main motive to effort. The movement from subsistence farming to cropping during the post-war period has been relative both to changes in the world economic situation and to the restrictive influence of natural factors in the narrower domestic habitat. It is difficult to define the conception of a "money crop." The extensive production of the world's great "colonial" areas is at once suggested by it. Nevertheless if production with a view to sale at a profit, either in the sphere of cropping or of animal husbandry, is the meaning inferred, it is safe to affirm that Finland is climbing the ascending ladder of agricultural production. The evolution from subsistence farming to money cropping is a movement to a higher economic stage of production; but the effort to attain and to maintain a new form of output must become progressively more difficult in Finland, situated as it is upon the geographic margin of agricultural production.

AGRICULTURE AND TRADE

Perhaps the most important aspect of Finnish agriculture in recent years has been its close relationship with foreign trade. It is convenient to distinguish the active relation, i.e., that

connected with the export trade, from the passive relation, or the import connection. Agricultural produce constitutes 8 to 9 per cent of the total exports and is, presumably, capable of providing a larger proportion. This export, comparatively small as it is, is a valuable corrective to the overweening dependence of Finland upon its timber and allied exports. The vulnerability of the Finnish export trade as a result of its alignment behind the solid "wooden front" of its export (which constitutes approximately 85 per cent) is great. Prosperity in Finland is highly susceptible to the state of the market for timber and its derivatives. While the export of farm produce—chiefly dairy products—is wholly independent of the price of timber *per se*, the extent of the market reveals similar oscillations. Dairy produce, like timber and paper, is greatly influenced by changes in world trade prosperity. Yet while dairy produce exported constitutes an unduly significant part in the export table in view of the general structure of the latter, it represents, at the same time, a surplus. Agriculture is oriented primarily towards the domestic market and it is only after home demands are exhausted that the overseas market is sought. The situation, however, is modified somewhat by two facts. First, the actual consuming capacity of the Finnish population for goods offered is less than the output in most cases, in the first place because agriculture is the greatest industry *per se;* in the second place because of the relatively small home population. Second, the restricted range of products grown automatically limits propensity to consume home produce in so far as the desired commodities can be obtained through international trade. With respect to a potential increase in the export of agricultural produce, several factors push themselves to the fore. First, the amount exported is closely correlated with the volume of exports of timber etc. When trade in timber exports is good, agricultural export declines in relative importance—not only because of the ascendancy of timber, but because of expansion of domestic demand consequent upon prosperity. When trade in timber exports is poorer, in so far as there is no coincident decline in relevant agricultural prices, agriculture will first attempt to correct the deficiency and, in light of the struggle between agricultural land and timber yielding land which is considered below, may tend to encroach slightly upon the forests. Increased export of agricultural produce must, however, in the final place be largely a function of the import trade. Paradoxical as this may sound, it leads to a consideration of one of the most important aspects of Finnish agriculture.

The relation of agriculture in Finland to the import trade is twofold. The agriculturalists as a consuming body constitute a larger mass than those engaged in industry. Other things being equal, their demands will therefore color the import table. This is particularly noticeable where a port, such as Turku, although an urbanization of no mean dimensions for Finland, is backed by a fairly densely populated agrarian hinterland. In the second place, the nature of imports demanded by the farmers shows a close dependence upon geographic environment. Those consumers' goods which they formerly obtained from abroad, are now largely bought from domestic industry: many capital goods are also manufactured within the country, e.g., agricultural machinery, dairy requisites, etc., but large quantities of "raw materials" have still to be imported to make up the deficiency produced through natural geographic factors. Edaphic and climatic influences

can be modified both in the realm of agriculture *per se* and of stock rearing by increasing the scale of imports. Although scientific research is lessening the dependence of crop rearing upon the import trade and although an expansion of hay yielding land is eliminating slowly the demands in the overseas fodder market by Finnish farmers, both forms of activity are still largely a function of the import table. Let us consider stock rearing in this light. The cow has, since remote antiquity, been an integral part of Finnish economy. It has been a reliable source of primary foods when crop rearing has been precarious in virtue of the climate. Compared with the capacity of the country to produce other crops it is eminently suitable in large areas for dairying. This is attested by Vidal be la Blache. Animal husbandry has always been in the ascendant in Finland and, as a result, meadow and pasture land have assumed a significance greater than that of crop land. Hitherto, all grain crops have been subsidiary to the fundamental hay crop. Although animal husbandry is less intensive than in the dairying countries *par excellence*, its evolution in Finland (particularly during the post-war period) has been none the less rapid and its organization no less efficient. Both as a result of concentration of cattle in the country (there are approximately 1,319,000) and of climate, fodder crops take precedence over food crops. The natural factors governing production of fodder crops are interesting. It is, in the first place, highly important to remember that the season of outdoor grazing in Finland (as is seen in Figure 10) is absolutely short. The maximum is about four months in the south, and three months in the north. This means that stall feeding is necessary for two-thirds of the year in the south and for three-quarters of the year in the north. During the brief season when pastures are available for outdoor grazing, the farmer is also anxious to obtain from these same pastures the bulk of his fodder for the winter months. Inadequacy of home grown fodder results therefore from the long period of stall feeding—which incidentally is at least three times as expensive as pasturing—from the insufficient area of cultivated meadow land (a point of great significance when, in the words of the Atlas

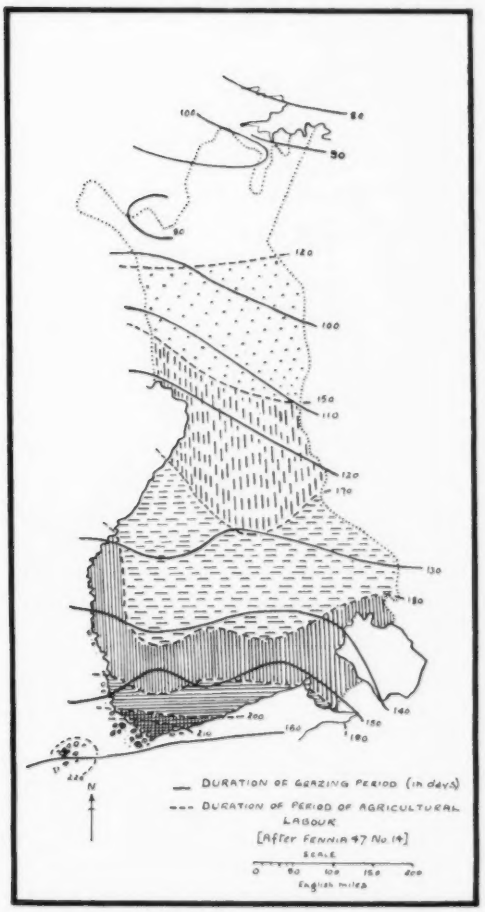


FIGURE 10.—The human agent can ameliorate his relation with natural factors by coöperating more fully with them. It is plainly evident in Finland, however, that there can be no ultimate escape from climatic tyranny. The clear-cut distinction between the seasonal forms of rural activity finds explanation in this map.

of Finland [1925] "Meadows are for the most part . . . products of culture"), and from the competition of alternate crops not only for land already cultivated, but also for funds set aside by the government for extension of improved land.

The pinch of capital deficiency is noticeable here and competition is rendered more acute by the veritable *battaglio del grano* which is evident in Finland at the present time. Given sufficient capital funds for investment, fodder imports are capable of being reduced to considerable extent: because there are extensive areas of potential meadow land, for which competition from alternative crops would be small. Improved methods of ensilage also counteract the need for more succulent forms of food. One important result follows from conditions under which the producer of dairy produce in Finland is laboring. The absolute costs of his product in terms of human effort are far greater than those in the dairy produce regions of more favorable climes. It is only his relatively low wages and the standard of the produce which permit the degree of success attained in overseas markets.

While dwelling upon this subject, it is interesting to notice that little expansion in the export of dairy produce will have to be attributed to modifications in domestic consumption. The increasing consumption of margarine in Denmark in order that butter exports might be made at a more competitive level, has no parallel in Finland, where perhaps it is possible to say that a more rigorous climate demands liberal consumption of higher standard fats on the part of the human agent to endure the winter season.

There have been ameliorations in the capacity of the country to produce fodder crops since the pre-war period. The degree of relative dependence upon external sources has declined. The reliance of Finland upon overseas sources of fodder supply had drastic effects upon her animal husbandry during the Great War. An all round deterioration was apparent with the trade blockade. Reduction of output of animals under wartime economy and general decline in quality was a direct result of cessation of imports. At the present time, however, it is not incorrect to argue that the exceedingly high nutritive value of Finnish milk, while partly to be attributed to scientific management of the farmstead as a whole, is also partly a function of the ability of the country to import certain foreign feeding materials. The same conclusion is to be drawn with regard to crop cultivation.

Crop production is dependent upon the import table: first, as a result of the relative infertility of large areas of cultivated soil; second, because of the comparative exhaustion of better lands in the face of continuous cropping, even if rotation is practised; third, because of the inadequacy of cattle manure to provide for the requirements of the cultivated area (reference being made to its relative paucity); and finally, the lack of means for providing the requisite artificial manure within the confines of the domestic economy.

Natural and artificial fertilizers therefore provide a fairly important percentage of the import table although, with increasing demand, the figure stands relatively stable—a fact which points to success of synthetic home production. During recent years the economic boundary of production in Finland has shown an absolute expansion as a whole as well as a relative expansion in the field of some products partly at the expense of other products. Although exceedingly difficult, it would be highly interesting to discover to what

extent the expansion is a function of imports of foreign materials (whatever their form) and to what degree it is the product of purely domestic activity. Direct imports for agriculture show a progressive decline from the relative standpoint owing to the absolute rise in "industrial" requirements.

A brief study of the dairying industry and of crop production as a whole leads immediately to the conclusion that Finnish agriculture is not an isolated entity pursuing an existence within and for the domestic economy, in spite of the fact that it is oriented towards it. The agricultural economy is subjected to the vicissitudes which disturb the world of agriculture: while the strategic condition of the country makes retention of peace as vital a concern for agricultural process, *per se*, as for timber producing industries.

Finnish agriculture is vulnerable to world changes, through the medium of the timber industry and through its participation in supplying the limited foreign market which is offered for the world's dairy produce. Alterations of the price level in this market and oscillations in demand resulting from the rhythmic motion of the trade cycle have profound effects upon the prosperity of the Finnish farmer. The passive, or import relation, is highly imperative. The Finnish agriculturalists are the most numerous producers and comprise the greatest number of consumers: considerably more than 60 per cent are engaged in farming. Their demands are for the requirements for effective production and for complementary products both from the sphere of industry and from other agricultural regions.

Finnish agriculture is dependent to a large measure upon the free flow of agricultural raw materials and complementary agricultural produce between regions of differing productivity or, in the special case of fertilizers and fodder supplies, regions capable of yielding supplementary resources. Any obstruction of this free flow—a flow which is set in motion by geographic environment—must, *ceteris paribus*, result in a progressive deterioration of the agricultural situation in Finland.

AGRICULTURE AND FORESTRY

Before considering the further implications of this state of affairs, it may be expedient to discuss two other relationships which have recently pushed themselves to the forefront of the agricultural sphere in Finland. There is, first, the age-old relationship between agriculture and forestry, which in light of more recent years has assumed a new orientation. Second, there is the relatively new relationship between agriculture and industry. In each relationship there is developing an antithesis which must have far-reaching effects. In some measure the struggle between agriculture and industry which is making itself felt in the national economy re-emerges in the newer opposition between agriculture and forestry. In so far as Finland has become an integral part of world economy, so far has industry gained precedence over agriculture in international relationships.

In spite of the fact that at least 80 per cent of the total exports of the country consist of processed commodities from industry and that less than 10 per cent are of purely agricultural origin, the agrarian element is loathe to yield precedence to the industrial element. The wealth of Finland has increased progressively with growth of its export trade in timber and its refined products. Of the vigorous import of commodities which has taken place, the rural community has absorbed

large quantities which have been offset in the trade balance by manufactured commodities. Finnish industry therefore provides, in the final place, the means whereby Finnish agriculture can gain its requisites. Between rural and urban elements in Finland there must be a spirit of compromise, because since the days when Adam Smith first emphasized the point, agriculture and industry are interdependent and not independent.

The degree of interdependency has grown with the economic evolution of the country and realization of the value derived from a harmonious working of the two is essential if constructive work in the domestic economy is to proceed at its present pace. Apart from the fact that tariff policies and the conduct of exchange relations are in opposite channels for agriculture and industry, there is also conflict produced by the attraction of labor away from the sphere of agriculture. Rural depopulation is most pronounced in the interior districts, in particular Mikkeli—although it must be noted that here it is often a relative rather than an absolute depopulation. The simultaneous growth of towns reflects the other side of this trend.

Yet there are tendencies in agriculture which seem likely to unite agriculture with industry rather than to divide the two forms of activity. In so far as agriculture becomes permeated with scientific knowledge and proceeds on its course with increasing enlightenment, it more closely resembles industry. The mechanization of agriculture and the industrialization arising out of agriculture both help to eliminate opposition.

Involved and complicated economic factors lie at the root of the struggle between land for agricultural and forest purposes. Since settlement was first permanent, the attachment of a strip of forest land to the individual farmstead has been the usual practice. It reveals the complementarity between agriculture and forestry. The supplementary purposes supplied by the forest have always been of fundamental value. So great is the importance attached to an adjacent strip of forest land that the Land Reform Act of 1922 made the following provision: that there be provided with every farmstead "a sufficiency of forest land as will supply at a normal rate of growth the amount of wood unavoidably necessary for household need."

The supplementary function of forest land which is privately owned is, therefore, first to provide for domestic needs. More important still, where relatively large areas of woodland are owned, is the provision of a relatively valuable supplementary income, since through sale of timber the farmer is able to offset partially expenses arising from his activity. The attached woodland is valuable from the complementary viewpoint, first, because it provides for a host of domestic needs which can, at best, only indirectly be obtained from the agricultural field (i.e. through exchange). Second, it provides an alternative occupation of great significance for the farmer during the winter months. Agricultural activity is brought to a standstill with the advent of winter, and were it not for the complementary forests wherein exploitation assumes a new significance in the face of frost and snow, agriculture would be reduced to a very lowly state.

If the extent to which the Finnish farmer is dependent on the soil, *per se*, were as great as that of his Danish cousin, his lot would be poor. Since agriculture ceases as soon as the snow cover becomes apparent, apart from maintenance of the cattle (which assume a new importance during the winter), the winter would become a dead season. The rhythm of the seasons rigorously

defines the nature of the farmer's activity and in Finland there is no toleration on the part of climate. Labor in the fields rises to a pitch of great intensity during the brief summer, when long hours of daylight would enable almost continuous operations if the human frame were sufficiently strong. Here, as the Odyssey (x 82ff) subtly alludes, "a sleepless man could earn double wages, . . . for the paths of night and day are close together." Work on the farm reaches its apogee with the harvest, then after a brief decline, is responsive to new demands of the winter season.

The presence of the forest, for the agriculturalist, modifies what Jensen terms the "alternative use value of a day's work." In summer farming operations, where labor is comparatively restricted in quantity, are the response to a number of calls of varying urgency, and the farmer will so distribute available human capacity as to maximize its use in any given operation. The alternative operations which are competing for the limited labor supply vary with the course of the seasons. The maximum competition of summer, in the absence of forests, might well stand in antithesis to a minimum competition in the winter. This would show an unfavorable distribution of activity and would promote an unhealthy winter stagnation. Under existing conditions even winter activity has an alternative use value.

How has opposition between agriculture and forestry in Finland come about? It may be described as a function of the relative price of forest products and the relative price of agricultural produce in conjunction with the comparative cost of raising any given piece of land to forest land of first quality or converting it into crop producing land at an adequate return.

FIGURE 11.—A farmstead at Pohjanmaa, remoter Ostrobothnia. The wide and shallow river valley, slightly entrenched in the marine plain, supports riparian settlement with simple farming upon a basis of relative self-sufficiency. (Courtesy of The Finnish Legation.)

There have always been the seeds of opposition between agriculture and forestry and the present antithesis is only an intensification of certain aspects of this opposition. The struggle between agriculture and forestry has been no less great in the past; because almost all of the settled land is the product of human culture, and there are practically no natural plainlands and drained meadowlands.

The present cultivated area (in the widest sense of that term) has been wrested from marshland and forest gradually during the course of the centuries. As Rätzel remarked, the history of a country, lying within the "Waldzone" is necessarily a contention between man and the forest. In the

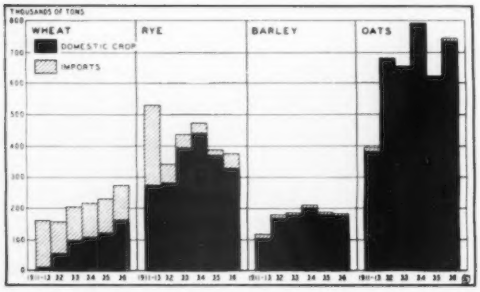


FIGURE 12.—Relation of harvest to imports for chief cereal crops of Finland.

past, however, it was economic value of the land won from the forests which was the standard observed. At the present time two criteria are apparent, *viz.*, the value of land as the producer of potential crops and its value as forest land. It is chiefly at the margin of cultivation that the struggle proceeds. Will the newly drained marshland bear hay and cereals or will it be afforested as timber yielding land of the first quality? This will depend upon a large number of factors, not merely economic, but also political and social.

AGRICULTURAL AUTARCHY

Among the latter, one stands out as of special importance. Recent years have witnessed in Finland a movement in favor of "autarchy" in the sphere of agriculture. The seeds of "autarchy" were sown in the country during the years of the depression, previous to which the newly autonomous republic had followed a policy of free and unrestricted trade. After 1927, the recurrence of an adverse trade balance necessitated relinquishing of the newly attained standard of living, reduction of imports to a figure compatible with the fall in exports, and pursuit of a source of relative self-sufficiency until Finland's markets were recaptured.

Among other things a new effort was made to re-introduce cereal production, which during the post-war period had waned slowly. As a means of reducing imports the encouragement of cereal production met with a measure of success. The unsettled international situation since the depression has promoted the cause of self-sufficiency—particularly in the case of grain crops—with the result that the measures introduced as a temporary antidote to economic recession have been retained in the interests of political strategy. If the renaissance of Finnish grain growing is an excellent example of the shift produced in the agricultural situation by imposition of a tariff, it is no less an illustration of what Chisholm has termed the influence of "Bread Power" on the economic and political history of a country. Formerly, foreign grains were imported at prices which made it impracticable to produce the less hardy cereals (except to a minor extent upon farms of a self-sufficing type which lay beyond the pale of most foreign influences).

Results of the ability to import cheap foreign grains during the post-war period were, first, an increase in consumption of wheat and an all round decline in human consumption of other temperate grains, whether from foreign or domestic sources; second, the comparative decline in home production of cereals both as a result of diminished consumption of varieties grown and the possibility of importing cheaper produce of equal quality. Resuscitation of grain growing behind the shelter of protective tariffs which has proceeded during the last decade reveals a number of distinctive characteristics. Figure 12 shows the absolute increase in cereal production and the new importance attached to the production of wheat. The imposition of tariffs, while checking the influx of foreign grains, has not modified greatly the new trends in consumption which were making themselves pronounced. It

is the remarkable increase absolutely and relatively in the area devoted to wheat and the nature of the returns which is the most striking feature of agriculture in recent years. The increase is not to be explained entirely by the great improvements in the yield as contrasted with the pre-war period.

It is rising productivity in conjunction with an increasing certainty of yield which is the most potent factor. Improved methods of tillage—introduction of machinery and cultivation of a deeper tilth, the more scientific utilization of both natural and artificial fertilizers, drainage ameliorations etc.—have partly enabled this. But it is the ever present menace of climatic variations which have hitherto been the chief obstruction in the way of returns of a comparatively constant nature. The limited length of the period of growth and the changing conditions of growth within this period have tended to produce a variability in yield. The climatic factor, which has opposed cultivation of wheat has come into conflict with the consuming element, which demands substitution, or expansion, of this cereal within the agricultural sphere. The compromise which has resulted has been the adoption of resistent grains, of which the ability to withstand drought and greater temperature reversions is tested. Quicker ripening species have not only enabled expansion of the potential area of cultivation for wheat, they have made certainty of the yield within the present areas of production greater.

Slow elimination of the uncertainty factor in harvesting in Finland may be regarded as one of the most revolutionary changes which has taken place in the nation's agriculture since the war. Independent of the reduction of this uncertainty factor (although in certain aspects connected with it) is the progressive increase in yields. Both the qualitative and the quantitative output of any land under cereals, which is cultivated in accordance with the principles of modern scientific farming, have shown a remarkable rise during the post-war period. The re-orientation of cropping in favor of wheat has had a number of influences. The renaissance is dependent first upon protection—in other words a certain redistribution of national income in favor of the agriculturalist has occurred. This redistribution has also tended to favor the crop farmer of the south as distinct from the stock and dairying farmer of the north. Beyond the limit of the successful margin of wheat production lies a farming system which gains little from protection of cereal growth. Yet there is no suggestion of dualism of the land owning system such as occurs in Germany and has resulted in the ultimate differential treatment in favor of larger land owners.

The second influence is a function of the soil factor. Wheat, in addition to being a marginal crop in Finland, is also an exhaustive crop. It is exhausting, even on rich soils, to support a wheat crop. The soils of Finland are everywhere comparatively poor. To raise the wheat crop to its present level, liberal fertilization of the soil has been necessary. In so far as imports of artificial fertilizers are responsible for this increase, the form of Finland's dependence upon external sources of supply has alone been altered and the degree of her dependence has fallen but little.

As a response to alterations in the pressure and form of external influences and modifying internal influences, the structure of the individual Finnish farmstead has changed greatly during the period since the war. If we consider some hypothetic farmstead in the south averaging some sixty acres in size, its

FIGURE 13.—Cattle in eastern Finland. "A cow for every month" is the ambition of Finnish agriculturalists. Summer grazing on artificial meadowlands is possible for only a quarter of the year in the north and east. (Courtesy of The Finnish Legation.)

peasant owner closely associated with the efflorescence of agricultural societies of his district, a succession of changes can be witnessed as modifying the outlines of its contours during the last two decades.

Just as the plan of a city and its growth or decay are on the one hand a function of local factors and on the other hand a response to more remote regional and inter-regional influences, so the plan of a farm—intimate unit though it may be—alters according to the relationship between local and international forces. The pace at which its outlines are changed is the vital factor. The degree of elasticity in the agricultural sphere is usually small. For the farmer it is the long period which is important—the same as in an urban accumulation morphological changes are necessarily slow.

What have been the alterations in emphasis which have characterized the swing of the pendulum in Finland during the post-war period? To what extent has Finnish agriculture—set as it is against a restrictive geographic background—been capable of adapting itself to these changes? The answer to the first question is relatively simple. During the pre-depression period, Finland concentrated upon dairying. The average farm became an intensively worked dairying unit, usually within the great coöperative system of Valio. So great was the transition from cropping to stock rearing and dairying that as early as 1925, the government was considering measures to restore the strategic grain element to its former position. During the pre-war period. Finland could safely concentrate upon the cattle rearing industry and neglect grain growing, because in the event of an emergency she had the prospect of being able to draw liberally upon reserves of the adjacent Russian storehouse.

The schism between Russia and Finland after the winning of Finnish autonomy closed the gateway to Russian grain sources. The cereal trade was oriented westward. In so far as cheap supplies were obtainable, the balance of trade was capable of permitting these and importation was free from obstacles. The procedure was entirely satisfactory. The renaissance of dairying was accompanied simultaneously by restoration of timber exports to their pre-war level and attainment of a new zenith in 1927. The effect of this upon Finnish economy as a whole was to stimulate a period of active investment. Industry expanded rapidly and agriculture, though altering its outward form less visibly by absorption of loans, pursued a similar program.

Responsibilities were incurred in agriculture and industry alike which weighed lightly upon the shoulders of the farmer and the entrepreneur in time of prosperity: but which were to become millstones about their necks with the appearance of adversity. One instance of the direction in which agricultural investments were absorbed is seen in the erection of expensive farm buildings. As a result of the climatic regime, the

onus of farm buildings upon the average farmer is great. Cattle (and any other animals) must be housed throughout the winter months: their foodstuffs must be stored under shelter (the ubiquitous hayrick of more fortunate climes is missing from the rural landscape of Finland): farm implements must be protected from the climate. Twenty-eight per cent of the entire capital outlay in Finnish agriculture is invested in farm buildings.

The fall in the buoyancy of agricultural prices which was the immediate result of the depression produced a more than proportionate decline in the income of the Finnish farmer with his fixed burden of debt. The decline was accentuated by the occurrence at the onslaught of the depression of a bad failure in the Finnish crops. Success of the farmer depends largely upon relationship between the average price which he receives for his produce and his aggregate costs of production. These aggregate costs of production will in turn be divided into fixed charges and variable charges.

Fixed charges have reference to his capital *per se:* variable charges are closely associated with the natural environment, that is, soil and climate. The cost of raising any given crop can be reduced to the cost of foregoing an alternative harvest. Possibilities of an alternative yield have to be considered in relation both to suitability of the season for its production and volume of production in other producing regions. The margin between the average price which the farmer therefore receives for his crop and his aggregate costs of production is variable between relatively wide limits.

The long period changes in the price of his fundamental requisites, balanced against the short period changes in the price which he receives for his output, introduce another uncertainty into the agricultural relationship which, like the factor of climatic uncertainty, can be reduced within certain limits, but must always be, in some measure, a disturbing factor. While the farmer may receive a wide margin of profits, he may more likely experience negative returns. In the final place, it is the relationship between the farmer and the natural agents which is the root difficulty. He is unable to adapt rapidly the form and

FIGURE 14.—Milking time in eastern Finland. Female labor employed in milking for local consumption only! The smoke is intended to keep away insects. The soil in the foreground is typical of glacial deposition. Later the cattle will be turned loose in the forest where they have grazed since the time of the Kalevalan Heroes. The sterility and primitiveness of the east contrast with the relative fertility and advance of the west. (Courtesy of The Finnish Legation.)

supply of his products to the modifications in the effective demands of consumers.

Agriculture must always tend to conservatism because it is only during the long period that methods of production can be dynamic. The farmer as a passive agent must wait upon nature and, as we are aware, *natura non facit saltum*. At some point man must strike a compromise with the natural agents and in Finland, nature is less liberal in her concessions than in more southerly regions. The average farmer, like the entrepreneur in industry, attempts to coördinate his means of production so that he will obtain a profit when his plans materialize. If the entrepreneur receives a considerable part of his profit as a reward for bearing risks, how much more are the returns of the agriculturalist a payment for risk bearing? Not only has he to forecast modifications in the demands of his consumers; he has also to attempt to offset the incalculable risks resulting from climatic changes. In such a region as Finland, lying towards the margin of effective land cultivation, these risks attain a maximum.

AGRICULTURAL ADAPTABILITY

The high degree of adaptability which the Finnish agriculturalist has shown in his relation with the geographic environment is reproduced to a remarkable extent in his ready accommodation to changes in the economic sphere. The result has been that Finnish agriculture has, as a whole, shown an elasticity which has saved it from the failure which has beset the mother industry of a number of less fortunate countries. Finnish agriculture has a plasticity within the limited scope of its activity which enables as speedy an adaption to any given set of conditions as is possible in this particular sphere of activity. Thus, as soon as the channels through which exported dairy products had flowed were blocked, energy was immediately turned in other directions.

Two particular fields were rapidly exploited—poultry farming (with a view to egg export), and pig rearing (with a view to export of bacon and provision of the domestic supply of lard). In both cases the fundamental requisites for feeding were available—especially after the resuscitation of grain growing. These specific changes were accompanied by and formed part of a more widespread change. This was the change in the case of individual farmsteads away from monoculture, as expressed in dairying, towards multiculture. Diversification became the motto of the farming community—not because in the long run and under normal conditions it was the most economic form of agricultural method; but because it was admirably adapted to the immediate situation. Mixed agriculture became not only a means of offsetting the effects of depression; but also a means of insulating agriculture against further attack by distributing its activities over a wider field. The vulnerable position of the individual farmstead with its emphasis upon cattle rearing was reduced by the reintroduction of a relatively generous mixture of crops.

The lot of the average agriculturalist has also been improved by the renaissance of grain growing. It has strengthened his position in the first place by guaranteeing a certain market for at least one part of his crop and second by increasing the range of alternate commodities which it is economically possible to produce. On the whole, mixed agriculture is the form of activity most conveniently adapted to the Finnish farming system. In a nation of small holders, considerable concentration upon any one form of production to the

relative exclusion of other forms is unwise if, *ceteris paribus*, it is economic. Size of the farms encourages an intensive system of farming. Actually the small and medium sized farms claim to have more than 60 per cent of the ploughed land. The nature of the soil is such that it requires an intensive exploitation if yields are to be satisfactory. Rotational methods are at once more practicable where mixed farming is evident, while they maintain fertility without increasing outlay upon fertilizers. Specialization upon the individual farmstead has become increasingly an unwise, if not also an uneconomic, procedure.

The accompanying table (see page 220) illustrates the main items in the balance sheet of Finnish agriculture—expenses and returns being considered as a percentage. It summarizes many of the characteristics of Finnish farming because it attempts a division of the information according to individual types of farms. The channels into which income from agriculture flows are clearly revealed and each has its peculiar relationship with the geographic environment. Among "Other expenses," such items as electricity, which is becoming increasingly significant in the rural regions, are to be noted.

Agriculture in Finland has been an occupation which has required patient drudgery and persistent effort in the face of unrequited return. Finland is a "region of effort" in the most literal sense of that term. Even today in the remoter parts of the country where communications do not penetrate there is stamped indelibly upon the face of the rural worker the words, "In the sweat of thy face shalt thou eat bread." The spectre of famine which formerly haunted the countryside no longer stalks abroad; but among the country folk, eating remains a procedure of the utmost solemnity. The yield of the land is the reward of effort which cannot be lightly disregarded. As Juhani says, in Alexis Kiwi's epitome of primitive rural Finland, "We belong to a family used to fighting hunger, a family and a race." It is not long since famine last menaced the country—in 1866 the failure of food crops had disastrous consequences—but numberless ameliorations have revivified agriculture during the interval, and given to it an energy which had hitherto been latent. Agriculture in Finland, as a whole, is not impossible if it is unfortunate. The field of its possibilities has been widely extended and the natural factors which oppose its development have been combated with notable success. A new relationship seems to have sprung up between the geographic environment and the human agent. The immutable constancy of the former remains the same; but the ability of the latter to utilize more positively the prospects offered has virtually decreased the determining influence of the natural factors. It is, as it were, a new interpretation of the Finnish environment, wherein its potentialities are revealed as opposed to its limitations. The compromise between the human agent and his geographic background over the greater part of Finland, has, during recent years, been based upon positive rather than negative foundations. In the field of agriculture contacts have been multiplied so that individual changes in the natural environment are less pronounced. "Man, long the faithful disciple of the soil," as Vidal de la Blache terms him, has had his efforts rewarded in Finland. In Kalevala, the national epos of the country, there is a legend of a famous Sampo—a mill which ground an unfailing stream of corn, salt, and general wealth for the community. It was stolen and a dark age of poverty and distress fell upon the country. Out of

this epoch when the Finns, still as in the time of Tacitus, were for the most part "squalidly poor," the land is now emerging. The forest lands have become the Sampo of the new Finland, providing a source of present and future wealth; and agriculture, still the greatest single industry, functions as a major cog in the economic system of the country, supplying anew that measure of stability and balance which is so essential in the national existence.

STUDIES OF RIVER DEVELOPMENT IN THE KNOXVILLE-CHATTANOOGA AREA

Seven separate articles by as many different authors form this one integral series dealing with one of the geographic phases of the Tennessee Valley Authority work. The several papers, presented at the annual meeting of the Association of American Geographers at Cambridge last December, constitute an excellent illustration of the coördination of as many related fields of research into one integrated project, by the Land Planning Division, Department of Regional Planning Studies, of the Authority.

Section One

SETTING FOR THE WORK OF THE LAND PLANNING DIVISION

G. Donald Hudson

THE Tennessee Valley Authority is another chapter in a century of interest in utilization of a natural resource—the Tennessee River and its basin (Figure 1). This chapter is the story of unified control and development of the river for service of the region along its entire length. It includes flood control; a nine-foot channel for navigation from Paducah, Kentucky, 650 miles upstream to Knoxville, Tennessee; experiments in economical production of new fertilizers; production of incidental power and sale of surplus electricity; and research and plans looking toward effective utilization of the Valley's resources and the social and economic welfare of the Valley's people.

Drainage into a common river system gives the 41,000 square miles of Valley area its principal regional unity. Between the eastern and western limits of the region, this river system drains a diversity of landscapes that range from the steep forest-covered slopes of the Appalachians to the open, gently rolling lands of west Tennessee; from the beef-cattle farms of southwestern Virginia to the cotton fields of north Alabama and the tobacco patches of west Kentucky.

Two and one-quarter million people—nearly 100 per cent native-born and 90 per cent white—live and make their living in this Valley. Farming is the dominant way of life, spreading into virtually every portion of the Valley; coal mining is localized on the Cumberland Plateau; manufacturing is chiefly concentrated in a few urban centers that account for roughly one-fifth of the Valley's total population.

Economic returns from these occupations constitute a major problem. During the early thirties, the average per-capita spendable income ranged from one-third to less than one-half of that in the nation; the average value of all farm products per farm was less than one-half, and the average annual wage per factory worker was two-thirds, of the national averages. In fact, these averages for the Tennessee Valley fall short of those for the South as a whole.

Four years ago the Authority came into this diverse region to set up a program varied to meet diversity, but unified to meet the single objective of regional development. The nature of the program calls for two lines of action: One concerns river development—the

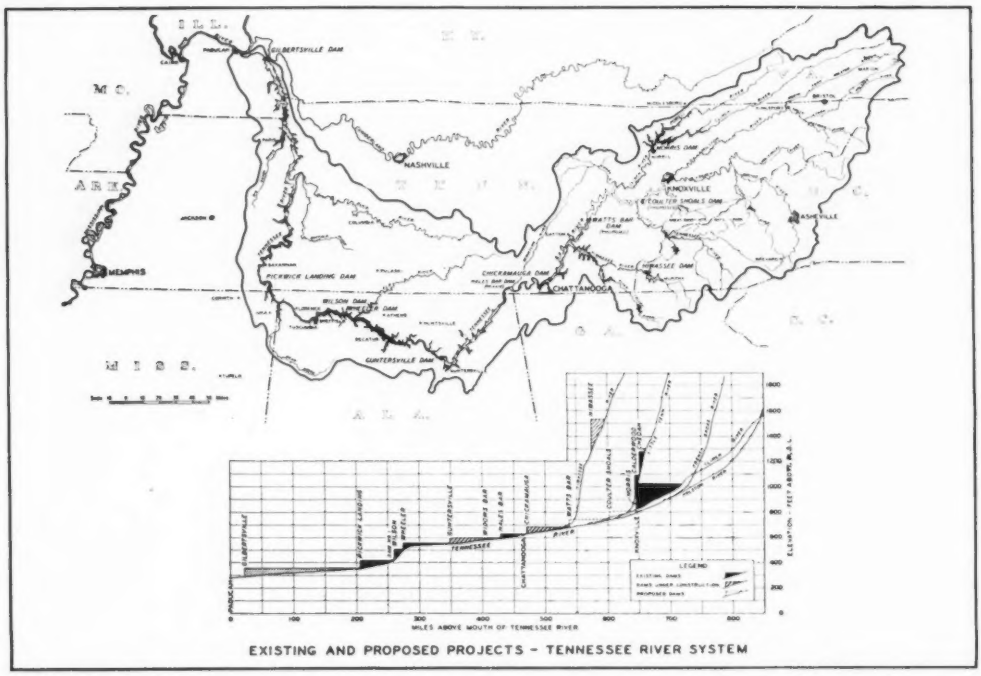


FIGURE 1.—The Tennessee Valley. Here in outline—the Tennessee River and its drainage basin—is the scene of the TVA's program of unified river development and control. This program, aimed at the service of the region along the entire length of the river system (41,000 square miles) consists of flood control, navigation, experimental production of new fertilizers, production of incidental power, and research and plans looking toward the social and economic welfare of the Valley's people (2,250,000).

construction of dams and reservoirs (Figure 2); the other relates to broad regional problems. The work of the Land Planning Division—one of three divisions in the Department of Regional Planning Studies—has been similarly organized. For example, the division has contributed to analyses of the social and economic effects of alternate engineering schemes of dam construction. At the same time, such studies as an inventory of scenic resources, an analysis of manufacturing, and the land classification survey have been going forward on a regional scale.

These two lines of work—reservoir and regional—are not mutually exclusive. Regional materials are utilized in the treatment of problems related to dam and reservoir construction, whereas findings growing out of reservoir studies play an important part in regional understandings.

Studies relating to river development have been selected as the major theme of this discussion of Land Planning Division activities largely because these studies offer concise examples of projects that have progressed through the early stages, in which research and planning are dominant, to later stages, when plans actually go into effect. In the discussion of work related to these projects, references are made to regional materials and the conditions, needs, and problems they reveal—subjects that can be reported upon more appropriately at a later date.

For purposes of continuity, most of the illustrations used here are drawn from river developments in the Knoxville-Chattanooga area. If TVA pro-

posals are carried out, dams will be built that will change the Tennessee between these two cities from a river to a series of reservoirs. One dam immediately above Chattanooga is already under construction. The construction of these dams and reservoirs means public purchase of privately owned and used land. The purchase of these lands and the accompanying relocation of population affect the functioning of local economic units. The creation of large reservoirs and the preservation of scenic surroundings, at the same time, add recreational assets that call for appraisal. Studies relating to these three topics—namely, land use, trade, and recreation—will be discussed in the next three sections.

How findings from these three lines of investigation are utilized in progressive stages of reservoir construction is presented in Section Five. The work covered by these four sections illustrates the relation of land-planning studies to stages in reservoir construction prior to the completion of land purchases and actual dam and power-house operation. They represent earlier stages in projects related to river development.

Before land purchases can be made, the boundaries of proposed purchases must be agreed upon and plans for the appropriate use of lands not actually flooded must be developed. The procedure developed for the treatment of these related problems is discussed in Section Six. The Gilbertsville Project is used to illustrate the procedure followed in determining purchase boundaries and in developing land-use plans; the Wheeler Project is used to illustrate the land-use plans after they have been completed.

FIGURE 2.—Norris Dam. This structure brings the Clinch and Powell Rivers—major tributaries—into the river-control program (Figure 1). Here, with the water at high level, the reservoir is shown in its capacity as a basin where flood waters are stored. During the seasons of lower rainfall the reservoir (with a maximum draw-down of sixty-five feet) performs a second function, becoming a source from which water is drawn to aid in maintaining consistent river levels on the main stream.

The concluding section draws regional understandings together in summary form. It thus serves as a summary and, at the same time, lays the groundwork for presentation at a later date of materials which will deal specifically with the Tennessee Valley on a regional scale.

Section Two

LAND USE ASPECTS OF RESERVOIR PROBLEMS

Aelred J. Gray

THE Tennessee Valley Authority's river-development program is aimed at the solution of existing problems such as control of flood waters (Figure 2). In the solution of these problems, creation of reservoirs—major elements in the program—gives rise to new problems. The discussion here will deal with problems created by reservoir construction which relate to regional land use.

When the Tennessee Valley Authority builds a dam, it buys land for the reservoir itself and, in addition, for a protective strip around the reservoir. The regional effects of the removal of this land from its present uses must be considered from three points of view: (1) the significance of the reduction in the total regional agricultural resource base, (2) the effects of the displacement of land on the regional farm economy,

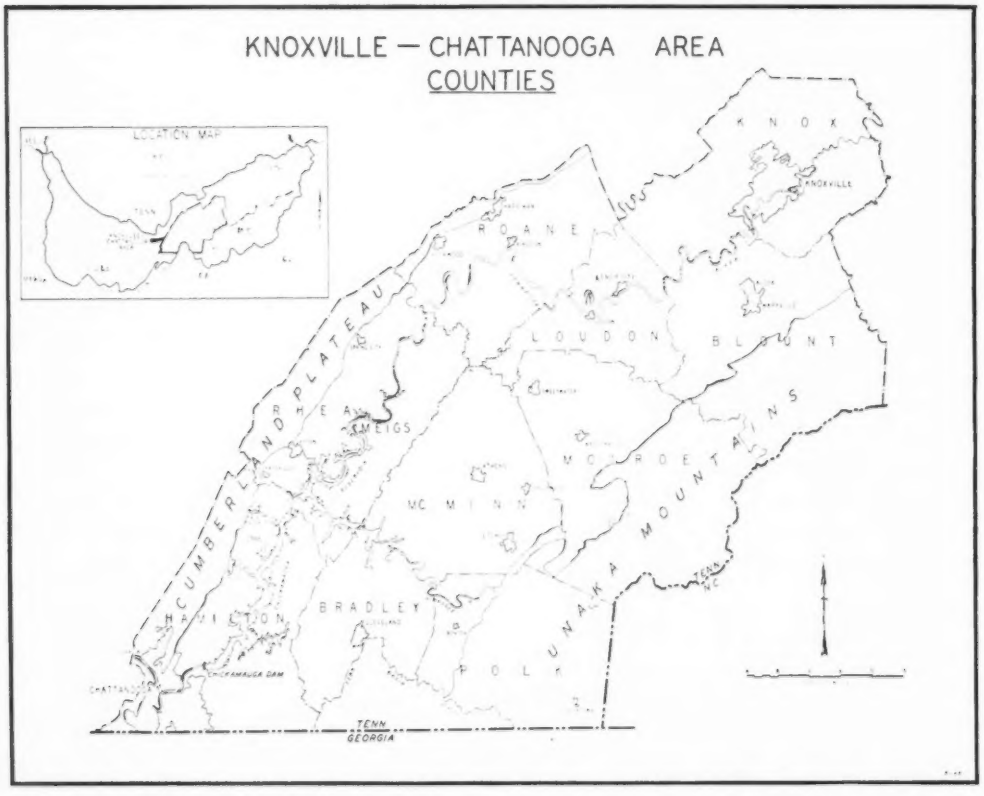


FIGURE 3.—The results of TVA dam and reservoir construction are both far-reaching and immediate. The storage of storm waters behind dams on the Tennessee (Figure 1) reduces flood damages as far away as the Lower Mississippi by lowering the crests of floods. In the immediate area land must be taken out of private ownership and use, and dislodged people must relocate. This change in land use and removal of population affects three major types of units, one of which is local governments represented by counties and municipalities. Between Knoxville and Chattanooga ten counties are directly affected by the river development projects now under construction or proposed for that portion of the Tennessee.

and (3) the displacement of population and the accompanying problem of relocation. In determination of the extent of these effects, data have been drawn largely from the Land Classification Survey—a Valley-wide inventory of land uses and resources—and have been supplemented by other information wherever available. (Hudson, G. Donald: "The Unit Area Method of Land Classification," *Annals, Association of American Geographers*, Vol. 26, 1936.)

With respect to the first of these effects—reduction in regional agricultural resource base—the projects proposed for the stretch of the Tennessee River between Knoxville and Chattanooga will take land from ten counties (Figure 3). These counties embrace roughly the southern half of the Valley of East Tennessee and portions of the bordering highlands—the Cumberland Plateau on the west and the Unaka Mountains on the east (Figure 4). The highland areas are rugged and forested and support only a few subsistence farmers and poverty-stricken families left stranded when mining and lumbering operations virtually ceased 20 years ago. At best, the highland areas are only remotely related to the problem. It is within the Valley portion of the Knoxville-Chattanooga area that the problem has its roots. This section, which contains the major concentrations of population, agriculture, and manufacturing, is marked by a characteristic ridge-and-valley structure (Figure 5). In the western half, the ridges are closely spaced, separated by narrow limestone valleys; in the eastern half, conversely, the valleys are broad and are separated by narrow ridges.

The ridge lands are not desirable agricultural areas. In the past they have served primarily as "back wash" areas, absorbing surplus population from the valleys and attracting industrial population which has lost employment with the cessation of lumbering and mining activities within the plateau. The pressure of existing population on the agricultural resource base is reflected in the fact that 47 per cent of the land used for agriculture in the Valley proper is ridge land (Figure 6). With the exception of some strawberry and peach production on the ridge from Dayton northward to Kingston, virtually all ridge-land agriculture is on a subsistence and low-grade general farming level. Very little of the ridge land is suited to continuous cropping since nearly all of it is dominated by slopes in excess of 20 per cent grade. Soils, derived from underlying dolomitic

FIGURE 4.—The setting for river development projects between Knoxville and Chattanooga includes the southern half of the Valley of East Tennessee and portions of the bordering Cumberland Plateau and Unaka Mountains. Because of their rugged, forest-covered slopes, and their sparse population, the highland areas are, in most respects, only remotely related to problems growing out of dam and reservoir construction. Reverse conditions together with land and population displacement combine to make the Valley the area of major concern. Reservoirs, on the other hand, will add major recreational assets to the Valley and, at the same time, enhance the assets natural to the bordering highland areas.

limestone, are cherty and relatively low in fertility. Slope and soil characteristics, together with constant cultivation without erosion-control practices, have resulted in widespread erosion, the destruction of land, and a general reduction in the inherent productivity of the soils. Ten per cent of the ridge land used for agriculture has been practically ruined by erosion, and an additional 85 per cent is in active sheet wash and gullying to a degree detrimental to continued agricultural use. Population density is relatively high. The number of acres per farm family average approximately 52 acres, about equally divided between cultivated, idle, and forested land. Lack of adequate resources and sufficiently large operating units are reflected in the large number of people on relief, the prevalence of tax delinquency, and the fact that public services —such as schools and roads—must be supported almost entirely by the more productive land and by state aids.

The valley lands, in contrast, are prosperous agricultural areas well suited to cultivation (Figure 7). They account for the remaining 53 per cent of the present agricultural land in the Valley proper. One-fourth of their area is dominated by slopes less than 10 per cent grade and an additional one-half by slopes between 10 and 20 per cent grade. Furthermore, the soils are productive, being either alluvial or derived

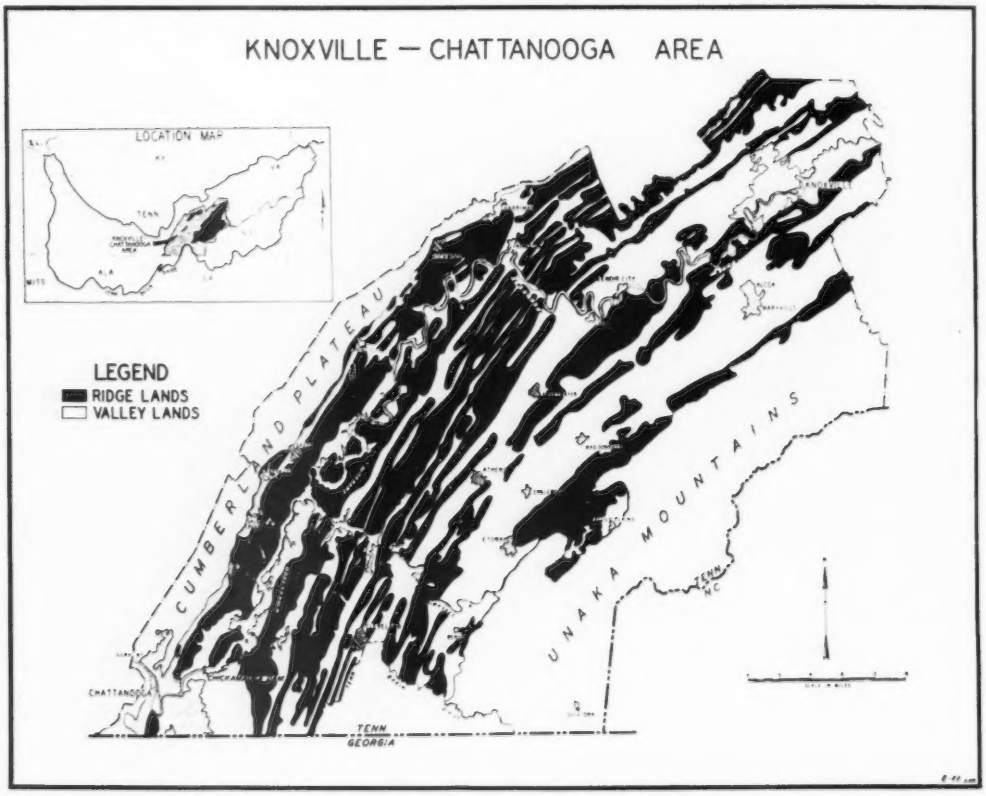


FIGURE 5.—The Valley portion of the Knoxville-Chattanooga area presents a longitudinal pattern of parallel ridges and valleys. Population pressure has been a major factor in bringing the ridge land under cultivation in spite of the fact that it is not well adapted to agricultural uses (Figure 6). Land in the valleys presents conditions more favorable to farming—few slopes exceed 20 per cent grade, soils are productive, problems of erosion are less severe (Figure 7).

from underlying limestone. General farming is dominant on the valley lands with here and there specialized types of farming, such as part-time, cash-crop, and animal industry. Livestock, milk, corn, wheat, and hay are the principal farm products.

Approximately half of the valley lands are actively eroding, but the problems of erosion are less severe than on the ridges. This is due in part to slope, soil, and similar factors, but also in part to the wider prevalence of erosion-control practices and larger farm units which permit distribution of cultivated crops on suitable land.

It is from this broad resource base of ridge and valley lands that the creation of reservoirs will remove land resources (Figures 5 and 8). It is in the remaining portions of this resource base that farm population dislodged by reservoir construction will look for new sources of income. Since Chickamauga is the only one of the dams between Knoxville and Chattanooga that has reached the stage of construction, it is used here to illustrate the analysis of the probable effects of reservoir construction on the local resource base (Figure 9).

Chickamauga Dam and Reservoir will take approximately 58,000 acres out of private ownership. Since continued use will be made of the protective strip, only the 25,000 acres to be flooded will be permanently retired from present productive use. This body of land constitutes only three per cent of the land now used for agriculture in the five counties adjoining Chickamauga Reservoir. Nearly three-fourths of the agricultural land thus removed is valley land, of which roughly half is bottom-land—the most productive farm land in the area. Even considering this higher productivity, the reservoir purchases actually will reduce the resource base of the five counties by only 5½ per cent.

FIGURE 6.—Forty-seven per cent of the land used for agriculture in the Valley portion of the Knoxville-Chattanooga area is ridge land. Here, relatively small operating units and unfavorable land conditions have led to subsistence and low-grade general farming as the dominant types of agriculture.

The losses to the resource base of the five counties are thus revealed to be relatively insignificant.

In terms of farm economy—the second major effect of the removal of land from agricultural use—the losses are greater, but still are far from critical. The most important crops grown on the lands to be purchased are corn, small grains, and forage crops. Of these, corn is the most significant since it is produced on almost half the land under cultivation in the area to be purchased. Formerly most of the crops from these lands were fed to hogs and to beef and dairy cattle. Improvement in roads, which broadened market possibilities, changed corn and some of the other crops from feed to cash crops, with sales concentrated in Chattanooga. In 1935, it is estimated that 75 per cent of the corn raised along the river was sold as a cash grain. Thus, with the declining use of corn produced on the bottom-lands for supplying local needs, the removal of these lands for reservoir purposes becomes correspondingly less significant to the regional farm economy.

The third major effect attendant

upon the withdrawal of reservoir lands from agricultural use is the displacement of population and its corollary problem of relocation. Chickamauga Reservoir will displace approximately 400 rural families, about equally divided between farm owners and farm tenants. Experience has shown on other reservoirs that, whether owner or tenant, displaced farm families tend merely to push back onto the lands immediately adjoining the areas from which they have been displaced rather than to migrate to more distant localities. In view of these circumstances, the regional resource base must be examined to determine the availability of farms as good or better than those formerly occupied by displaced families. Furthermore, relocation must be discouraged in those areas which now apparently contain excess population—areas in which relief expenditures are already being made and which require subsidies to continue the ordinary governmental service such as schools and roads.

FIGURE 7.—Between the ridges of the Valley portion of the Knoxville-Chattanooga area lie the better lands—accounting for 53 per cent of the agricultural lands of the area. General farming dominates. But here and there are distributed part-time, cash-crop, and livestock farms related in their operation to nearby urban centers that provide employment and ready markets for farm produce, fruit, livestock, and livestock products.

In order to determine what types of land offer the most promising opportunities for relocation, studies were made utilizing the findings from analyses of land resources in progress on a Valley-wide scale. These analyses, based on data from the land classification survey, soil maps, land-use studies, and the like, placed all land into three classes depending upon their best uses. These three classes were (1) areas suited to intensive uses (emphasis on cropping); (2) areas suited to extensive uses (emphasis on pasture and soil-conserving crops); and (3) areas suited to non-agricultural uses. Preliminary conclusions with respect to the problem of relocation indicated that relocation should be encouraged in areas of the first type and discouraged in areas of the last two types. To verify this conclusion, studies were made in other reservoir areas which correlated the success and failure of relocated families and the types of areas in which they settled. The results showed that four out of five families relocating in areas suited to intensive uses were successfully relocated, whereas only one out of five families that relocated in the other types of areas had been successful. Projecting these findings into the survey data for the area adjoining Chickamauga Reservoir makes it possible to delimit the areas to which displaced families should be encouraged to look for relocation possibilities.

Section Three

EFFECTS OF RESERVOIR CONSTRUCTION ON LOCAL ECONOMIC UNITS

Harold V. Miller

THE creation of dams and reservoirs on the Tennessee River between Knoxville and Chattanooga will, as noted in the preceding section, entail the retirement of lands from private use and bring about the removal and relocation of a body of population (Figure 3). This is particularly well illustrated by the Chickamauga project. Here not only will the main river be appreciably widened by the inundation of lands, but the valleys of tributary creeks will become arms of the reservoir reaching toward the six towns of the immediate area—Dayton, Sale Creek, and Soddy on the west side of the reservoir, and Decatur, Charleston, and Calhoun on the east side of the reservoir (Figure 10). Conditions thus brought about will directly affect those local economic units. It was the duty of the Department of Regional Planning

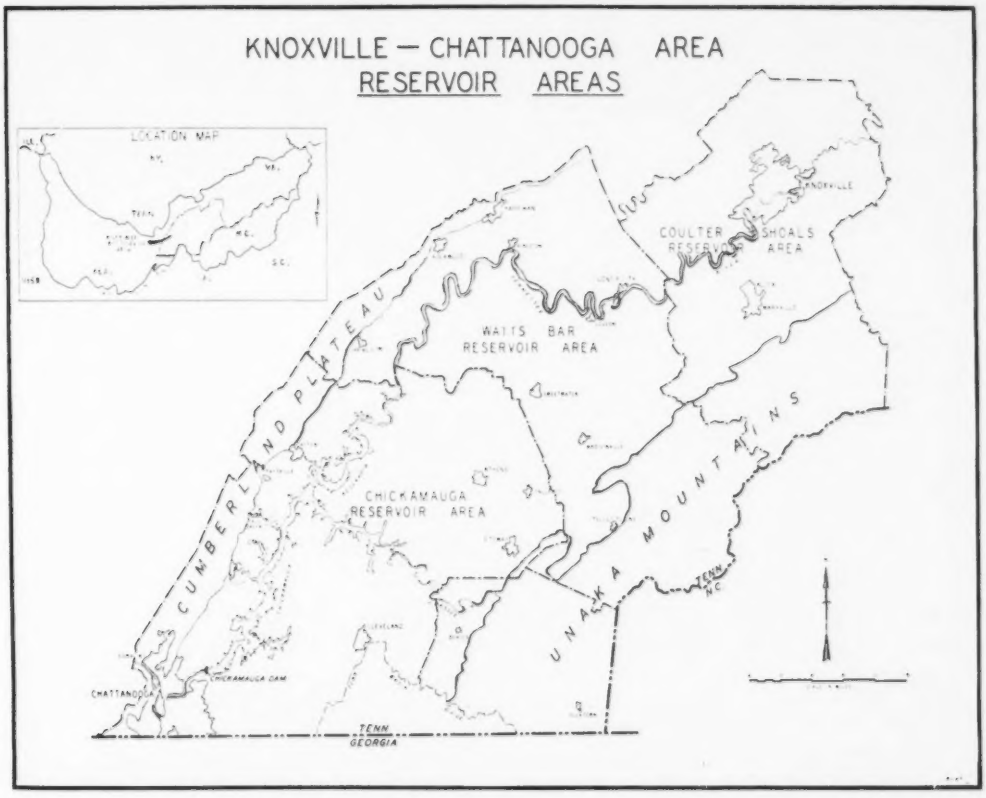


FIGURE 8.—A second type of unit affected by dam and reservoir construction is the reservoir area—the area within which are confined most of the effects of the public purchase of land and the displacement of population. Here are shown the "reservoir areas" of the Knoxville-Chattanooga area. Each serves as an important base against which can be measured the effects of its associated river-development project.

Studies to investigate and report on the effect of the removal of lands and people upon these local economic units.

Reconnaissance studies as well as previous field experience pointed toward movements of general retail trade as the most significant single indicator of the local economic unit. Furthermore, retail trade constitutes: (1) a single item for investigation thus effecting rapid coverage; (2) an index which can be checked both at the focal center and at the periphery of influence; and (3) a criterion more significant than is any single commodity or service item. It was foreseen that, if properly done, valuable results could be obtained at a minimum of cost. And, as future occasions permitted, studies could be extended over additional portions of the Valley, to provide an understanding of the retail trade structure and local economic units of the Valley as a whole.

FIGURE 9.—Chickamauga Dam, a few miles upstream from Chattanooga (Figure 1), is the only one of three planned for the Tennessee between Knoxville and Chattanooga that has reached the stage of construction. Roughly 25,000 acres will be flooded by Chickamauga Reservoir, thereby removing from production three per cent of land used for agriculture in the adjoining five counties (Figure 3). This reduction in land resources, although important locally, is of minor regional significance and is more than balanced by the flood-control and other benefits created by the project.

To provide these understandings, it was necessary to delimit each trade area with a rational single line to avoid overlap between the various centers and yet account for all of the area.

Trade area studies made in the Tennessee Valley are indebted to previous studies even though they did not exactly fit immediate needs. Studies such as that made by Dr. L. M. Davis, in Elwood, Indiana, and Paxson's Study of Onondaga County, New York, were, from the standpoint of immediate needs, unsatisfactory because they involve numerous boundary lines and are relatively costly in time and money. On the other hand, McKenzie's method of partitioning the United States on the basis of metropolitan newspaper circulation yielded single-line boundaries, but was far too generalized. (Davis, Leslie M.: "Service Areas of Elwood, Indiana," (Doctoral Dissertation) University of Chicago Libraries, 1935. Paxson, Alfred Moore: "Relationships of Open-Country Families of Onondaga County, N. Y., to Socio-Economic Areas, Villages, and Cities," *Bulletin 584*, Cornell University Experiment Station, Ithaca, New York, 1934. McKenzie, R. D.: *The Metropolitan Community*. New York, 1933. Figure 6.)

In establishing an intermediate plane of operation, it was decided to use a single boundary line drawn to enclose the area in which people customarily do the major portion of their trading in a common center. Such a line would not be all-inclusive, but would provide a rational basis for distributing the area and the people according to their affiliations with the various trade centers.

In practice, the field man interviews several representative merchants in a given trade center (a druggist, clothier, grocer, hardware merchant, etc.) to gather their opinions regarding the extent of the area from which they draw the majority of the retail trade in their respective lines.

Guided by a sketch map showing the

several more or less concentric lines thus obtained, the operator proceeds to the periphery of the area so delimited to locate the trade divide in more detail. He bases his final decision on interviews with families regarding the center at which most of their annual expenditures are made, but in the process makes use of any observable indices such as road turnings, roadside billboards, and the existence of specialized agricultural items known to be associated with a given center. The work is further advanced by attention to the existence of topographic and other features which commonly constitute barriers or hindrances to travel.

When the field operations are complete and the centers and their tributary areas are delimited, there are no blanks in the region (Figure 11). Overlapping is eliminated by the definition, which, to restate, is the delimitation, for a given center, of that area whose inhabitants customarily trade more with that center than with any other center.

The boundaries are plotted on planimetric maps so that specific houses can be allocated to their respective trade centers, and so that lands described by the Rural Land Classification can be likewise allocated.

Sale Creek, in the Chickamauga Reservoir Area, affords an example of the actual application of the findings of the trade area study (Figure 12). Sale Creek

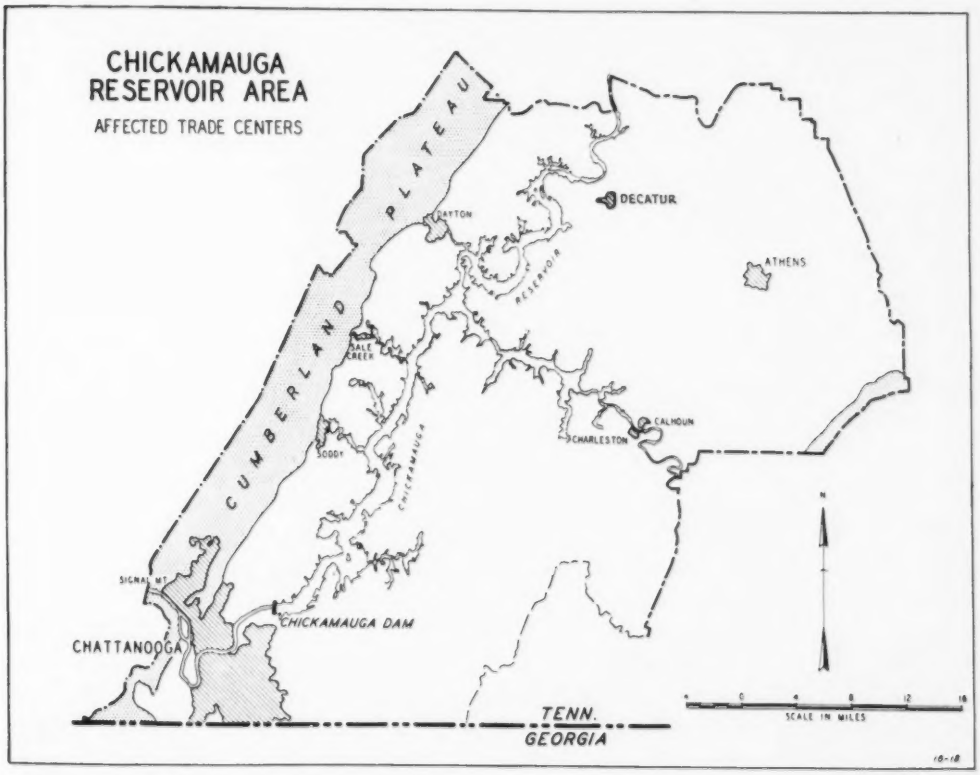


FIGURE 10.—The status of towns on or close to the reservoir may be disturbed in two ways: (1) through displacement of a part of the town itself; and (2) through displacement of rural families who, through their purchases, support the retail trade establishments at the trade centers. Of the trade centers in the Chickamauga Reservoir Area, only Soddy and Dayton will be physically affected by the reservoir. These physical effects will be of minor consequence. Displacement of rural families will be of sufficient magnitude to have appreciable, but probably not serious, effects upon retail trade in the case of Soddy, Sale Creek, Dayton, Decatur, Charleston, and Calhoun.

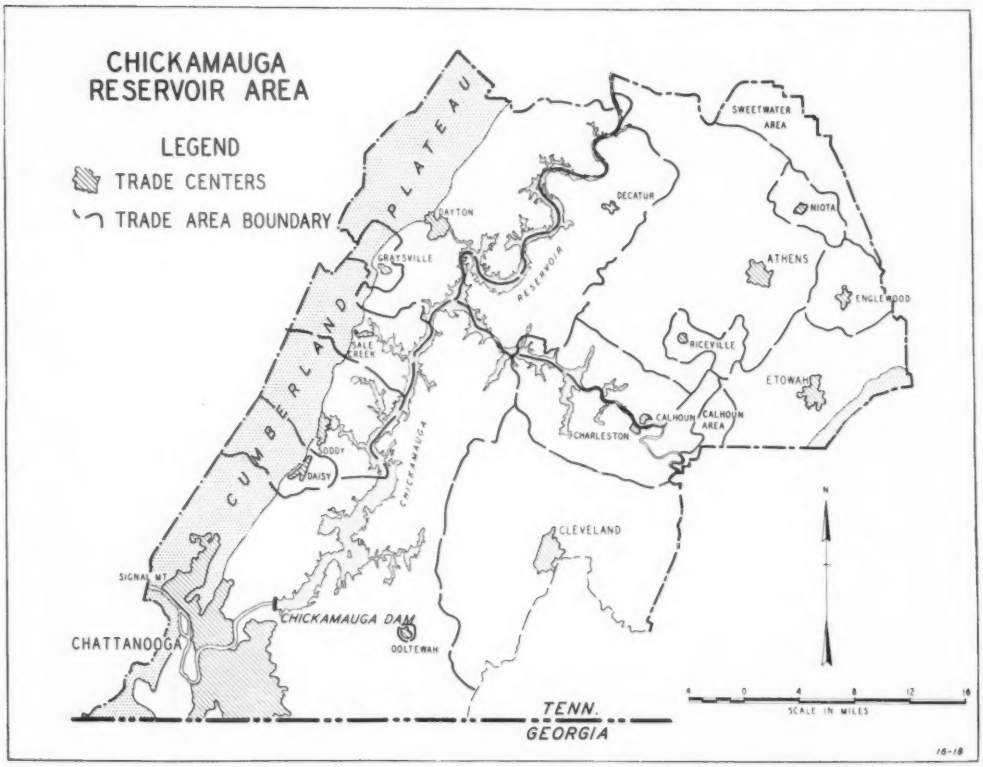


FIGURE 11.—Removing for reservoir use a portion of the resource base and displacing population from areas to be flooded reduce income to local trade centers by lowering the volume of retail trade. To discover whether or not these reductions in trade volume are critical to the economic stability of trade centers, a base of measurement is required. To provide this base, the area tributary to each center is determined by field investigations. The resulting trade area is the third type of unit considered. Here are the trade centers and areas—the retail trade pattern—of the Chickamauga Reservoir Area.

is a rural village of some 500 people, situated between the Cumberland Plateau and the Tennessee River, about midway of that stretch of the river which will shortly become Chickamauga Reservoir. An arm of the reservoir will reach westward almost touching the settlement. The town will not be flooded but the question is: Will the losses to its trade—its main source of livelihood—be of such significance as to force that economic unit into bankruptcy?

Analysis of Sale Creek's trade area indicated that Sale Creek handles the bulk of the retail business from an area of some 66 square miles, in which live about 1,900 people. Nearly two-thirds of the trade area lies on the Cumberland Plateau, but that portion contains only 11 per cent of the population. Furthermore, only one-fifth of the land in the trade area now used for agriculture lies on the Plateau. The Valley portion, therefore, though limited in size, contains nine-tenths of the people and four-fifths of the land used for agriculture, and it is in the Valley that inundation will occur.

It was found that reservoir purchases will remove about 7 per cent of Sale Creek's trade area. This total may seem small, but it includes 16 per cent of the Sale Creek unit's land now used for agriculture and 52 per cent of its best agricultural land. The people living on the land to be purchased constitute 7 per

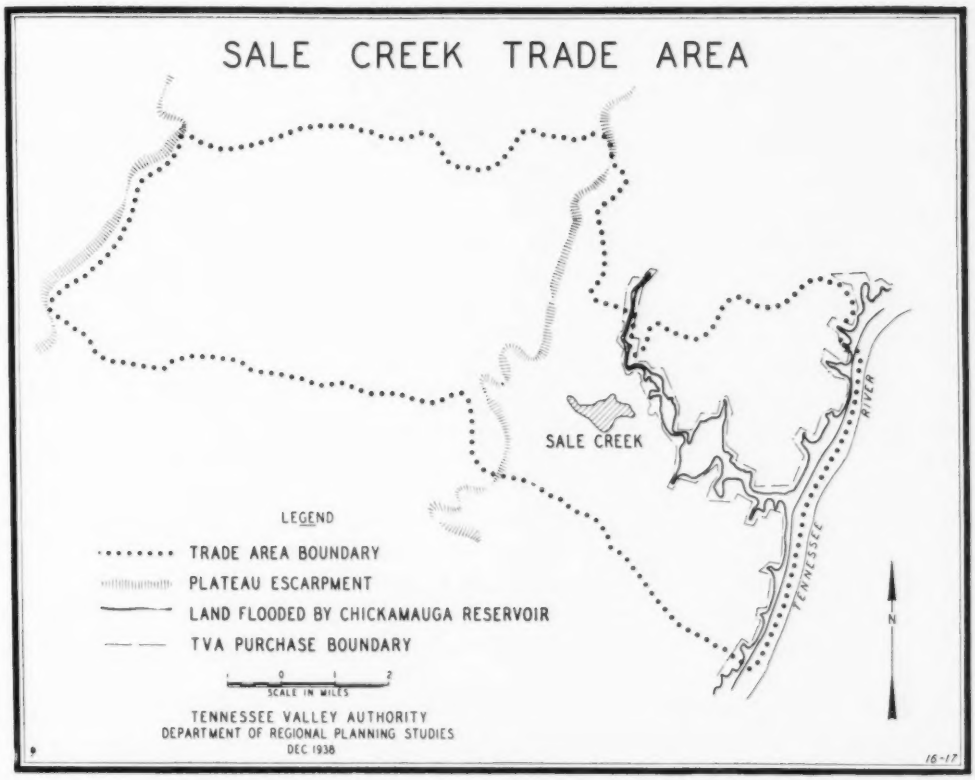


FIGURE 12.—Sale Creek as a local economic unit—trade center and area—serves as an example of the importance of this type of unit in measuring the effects of reservoir construction. Studies show that the losses to Sale Creek's trade—its major current source of livelihood—will not seriously impair its continued economic existence.

cent of the trade-area's total population, as determined by house counts from planimetric maps. Inasmuch as the farms are larger and the land more productive nearer the river—the area of purchase—the average annual expenditures per family displaced was estimated at $500, in comparison to the average of $320 for the trade area as a whole (Figure 7). Assuming, for purposes of the study, that all displaced population will leave the trade area, the total direct annual trade loss is estimated at $8,400, or 12.7 per cent of Sale Creek's business as reported by the merchants for 1935. These maximum figures are an exaggeration of what probably will take place, for past experience indicates that not all of the displaced population will move out of the trade area. In any case, the loss of a portion of the gross sales suffered by Sale Creek merchants can be absorbed or minimized by a slight retrenchment on their part, for none is burdened by excessive investments in real estate or shelf stocks.

In the future, Sale Creek should be able to retain its position among its competitors. It is favorably located, on both a railroad and a through highway, and at a distance of more than ten miles from its strongest competitors, Dayton and Soddy (Figure 13). Furthermore, it is at the point of convergence of several roads coming from the bottoms and from the plateau. In short, its location will encourage its patrons to continue to trade at that point.

Sale Creek is in a position to profit by any new developments in its area. In 1935, 80 per cent of its trade came from persons engaged in agriculture and forestry, and 16 per cent from persons on relief. Since 1935 farm income has risen, and more intensive use of suitable lands remaining in the area may further bolster the town's trade. Any development of the recreational resources of either Chickamauga Reservoir or the scenic Cumberland Plateau will help the town (Figure 14). Developments in manufacturing are difficult to predict, but such developments would seem reasonable for this community.

Though the technique of trade-area delimitation was developed to meet specific demands of the type described, it has been proven equally adaptable to use over a larger area. When trade-area data are available for the entire Valley, there will have been developed a useful tool and body of information never before available anywhere to aid in the analysis of a variety of problems and in the preparation of plans for areas truly regional in scope.

Some of the larger findings should be noted in conclusion. When the trade centers and their boundaries are plotted over an area of considerable size the trade structure becomes more apparent and more meaningful (Figure 15). Here in the Knoxville-Chattanooga area the pattern is characterized by the wide

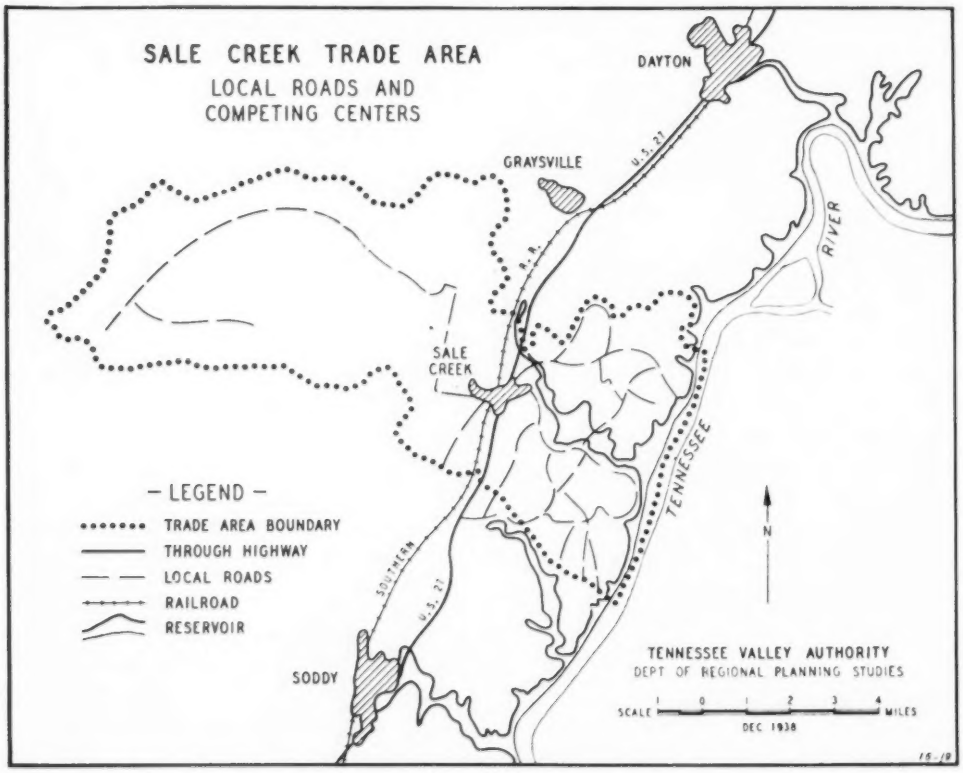


FIGURE 13.—Several factors point to Sale Creek's ability to maintain its economic stability and competitive position after reservoir construction. The Southern Railroad and U. S. Highway 27 give it effective connections to the north and to the south. Roads from the Bottoms and from across the Cumberland Plateau converge at Sale Creek. The town is ten miles from its strongest competitors—Dayton and Soddy. The commercial and other services are well geared to the needs of the town and the farm population it serves. The construction of Chickamauga Lake will add recreational assets from which the town unquestionably will benefit.

spread of the trade areas of the principal two centers, one at either end of the corridor. The pattern of the intervening trade areas is one of great irregularity. There is more order in the pattern of the centers themselves. Most striking is the alignment of the centers along the two major routes of travel separated by the Tennessee River—one through Athens and one through Dayton. Less distinct alignments follow less important travelways along the foot of the Unakas through Madisonville, and down the Sequatchie Valley through Pikeville.

In general, there is a direct relationship, as might be expected, between the size of a trade area and the attractiveness of its center as a place to do business. Exceptions exist, as in cases where metropolitan centers overshadow smaller centers. Many factors enter into the exact location of trade "divides," a few of which are illustrated by the following examples taken from the Knoxville-Chattanooga area (Figure 15): The existence of a better road from the west to Sweetwater has extended the trade area in that direction. Part of the boundary between the Chattanooga and Cleveland trade areas is formed by White Oak Mountain, which is uncrossed by roads for some miles. Dairy specialization in the vicinity of Ooltewah is geared to the Chattanooga market, and, as a result, the dairymen's retail affiliations are with the latter center though the town of Ooltewah is closer. In the case of Whitwell, few farmers are willing to trade at the coal company's commissary, and as a result content themselves with relatively infrequent trading trips to Chattanooga.

Section Four

RECREATIONAL OPPORTUNITIES ARISING FROM RESERVOIR CONSTRUCTION

Robert M. Howes

THE Tennessee Valley today is the nation's newest frontier of recreational exploration. Although recreation development has occurred sporadically in the Valley at such places as Asheville, N. C., and Monteagle, Tenn., the rich natural recreational resources of the Valley as a whole have remained undeveloped and known only to those comparatively few visitors who braved an area inadequately served by either highways or accommodations. The Valley's mountain scenery, its luxuriant forests, its tumbling streams, its inviting climate were undiscovered by most of the nation's 120,000,000 people, two-thirds of whom live within 500 miles of the Valley (Figure 16).

Recognition of recreational potentialities within the Valley awakened with the move to establish the Great Smoky Mountains National Park (Figure 17).

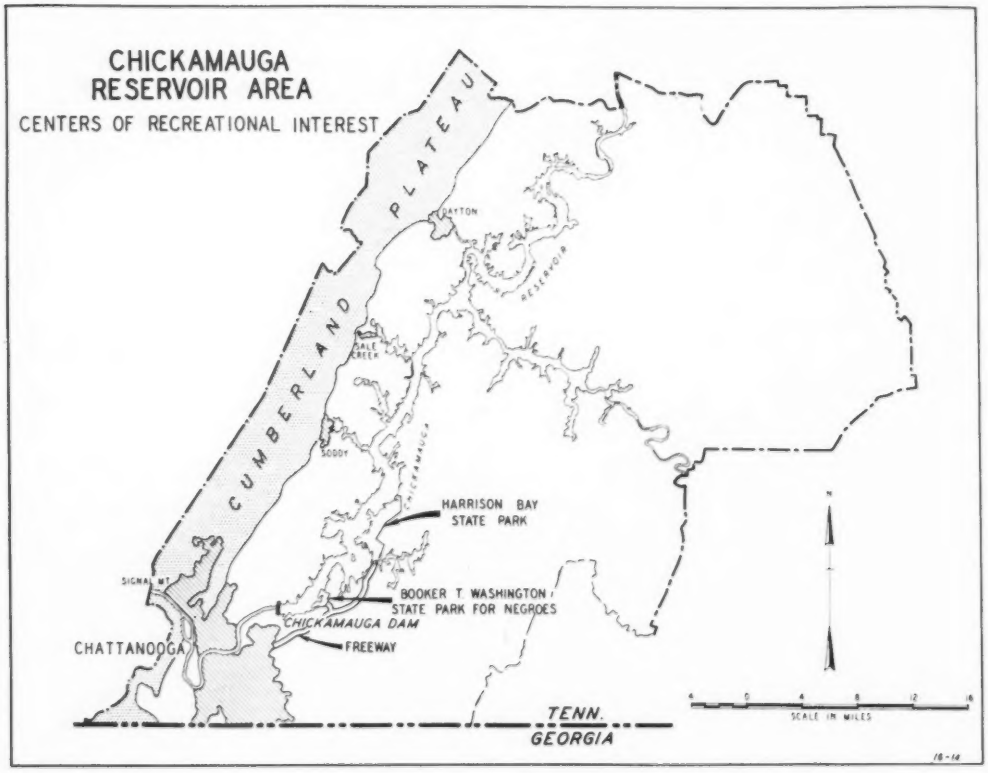


FIGURE 14.—The new recreational resource provided by the reservoir creates opportunities for new activities which will tend to offset the effects of land displacement. Of the reservoir towns, Dayton, Sale Creek, and Soddy have particularly favorable sites for recreational developments. At other indicated sites, the Authority in coöperation with state and federal agencies is aiding in the establishment of public, waterside parks.

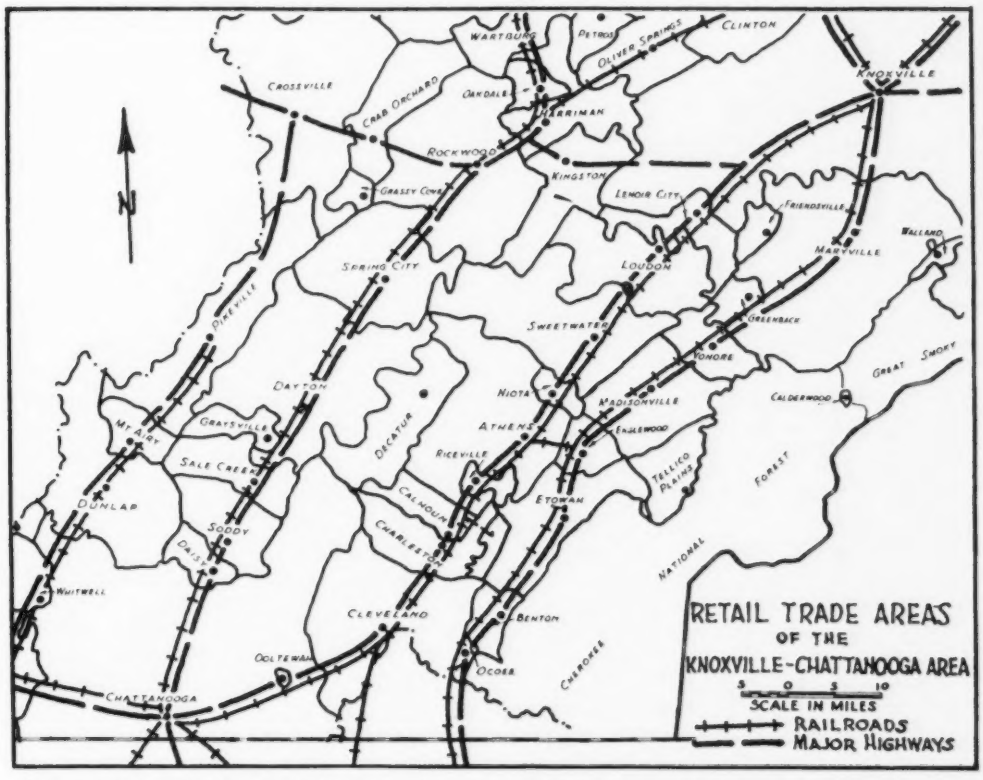


FIGURE 15.—Individual units in the pattern of retail trade areas differ greatly in size and shape. The fact that the greater attractiveness of larger centers, in general, enables them to develop larger trade areas is well illustrated by the very large areas tributary to the urban centers of Knoxville and Chattanooga, at opposite corners of the area shown here. Ease of access to a center as affected by the local road pattern and physical features largely accounts for irregularities in the outlines of the trade areas. In contrast to the irregularity of the trade area pattern it will be noted that the trade centers show a marked alignment along the major northeast-southwest routes of travel.

Activities of federal agencies, recent legislation, popular novels, dramas, and works of non-fiction—even cold economic reports—have further served to focus the attention of the nation on the Tennessee Valley and on the South, of which it is a part. As a result, many a northern tourist has been prompted to travel southward to see first-hand the subjects of which he has read and heard. In company with other hundreds of thousands, he visits the Great Smokies, Lookout Mountain, Norris Dam and other places of interest, overcrowds available accommodations and returns home with the realization that he has discovered a new vacation land (Figures 2 and 17).

The Tennessee Valley Authority recognizes in the recreational potentialities of the Valley a new playground for the people of the nation and, in the increased tourist activity, a new and major source of income for the people of the Valley. Limited to the three activities of research, planning, and demonstration, the Authority's program has included (1) inventories of the Valley's scenic and recreational resources—information which has been brought to the attention of the public, (2) plans for the development of these resources—guides toward an integrated regional program of activity by numerous agencies both public and private, and (3) the setting aside of recreation areas and development of

type facilities on TVA property—patterns of recreational development that other agencies can follow.

In this brief discussion of the recreational studies being undertaken by the Authority's Land Planning Division, our attention is focussed on the river development program within the Knoxville-Chattanooga area (Figure 9). For illustrative purposes we can still further limit the discussion to Chickamauga Lake, which has been studied in a manner similar to that applied to other lakes and to the region as a whole (Figure 14).

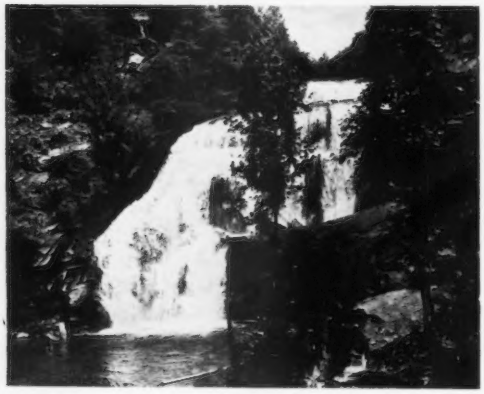


FIGURE 16.—Little known by most of the nation until recent years are such attractions of the mountainous part of the Tennessee Valley as these seen here in the fishing pool at the foot of Bald River Falls in the Cherokee National Forest.

Recreational studies of Chickamauga Lake were inaugurated by an inventory of resources which led to a preliminary report on its potentialities for recreation development. This inventory considered the natural character of the lake and its setting; the suitability of its water for various water sports; the physical character, climate, land uses, and travelway pattern of its hinterland; the social and economic status of people living in that hinterland; and the presence or absence of neighboring recreation areas which might supplement or compete with recreational developments on the lake. An analysis of factors disclosed by this inventory led to conclusions which can be summarized briefly.

The lake will be naturally suitable for a wide variety of water sports. Its relative clarity and broad water surfaces will invite nearly every form of pleasure boating. Its freedom from serious pollution and its water temperatures in summer will be conducive to swimming and good fishing. Although the level of the lake may fluctuate a maximum vertical distance of 12 feet, the normal fluctuation during the recreation season will be but 3 feet, a variation which may easily be anticipated in the design of bathing beaches, docks, floats, and other shore facilities (Figure 18). Five hundred miles of shoreline afford many sites naturally suitable for outing parks, group camps, cottage colonies, picnic areas, and similar features. Chickamauga Lake, moreover, will complement the natural recreational resources of the adjacent highlands in the Unaka Mountains and on the Cumberland Plateau—areas best suited to extensive uses such as hiking, fishing, and hunting (Figure 4).

Recreation facilities on Chickamauga Lake will be patronized by both tourists and local residents (Figure 19). Tourist patronage can be expected from travellers on five federal highways which lead from all parts of eastern United States to within five miles of the lake shore. Investigations show that regular local patronage of any recreation feature can be expected from persons living within a few hours' drive or less from that feature. In the case of Chickamauga Lake, an arbitrary 50-mile radius was first assumed. The boundary so determined was then refined on the basis of highway pattern, travel habits, and (for statistical purposes) county lines to include 12 counties in northwest Georgia and

FIGURE 17.—Creation of the Great Smoky Mountains National Park marked national recognition of recreational potentialities within the Tennessee Valley. This view southward from Clingmans Dome, which may now be reached by automobile, shows the typical forested slopes of the furrowed mountainous mass included within the Park.

southeast Tennessee (Figure 20). These counties in 1930 had a population of 330,000 persons, more than a third of whom lived in Chattanooga, virtually at the damsite. Within this local patronage territory, higher urban incomes indicate that patronage of recreation facilities for which charges must be made will come from cities and towns rather than from rural districts. The territory of economic benefit—that is, the area into which expenditures for recreation will bring new income, will include the three counties immediately bordering the lake. These expenditures to a considerable extent will benefit rural districts in which incomes at present are substantially below the Valley average. The most serious competition from neighboring recreation areas will come from other lakes of the Authority or of private power companies. Such competitive effects, however, will be more than offset by the supplementary attractions of such features as the Chickamauga and Chattanooga National Military Park, Lookout Mountain, and nearby national forests.

Comparative studies, undertaken to establish the position of Chickamauga Lake in relation to other lakes of the Tennessee River chain, show that only Norris Lake appears to afford superior over-all potentialities for recreation development. Chickamauga is more favorably located than any other lake in the Valley with respect to local urban population and tourist highways. Its setting is less spectacular than that of many other lakes, its shorelands of less scenic interest and less adapted to recreation uses than others of the chain, but no lake exceeds it in potentialities for water uses. Malaria can be more easily controlled on Chickamauga than on lakes farther downstream, but control problems will be more acute than on those lakes which are above it.

Plans for recreational development have been related to specific sites having outstanding natural qualifications for recreational use and to communities which have a strategic physical relation-

FIGURE 18.—In its program of demonstrations to show desirable utilization of recreational resources in the Tennessee Valley the Authority, in coöperation with other governmental agencies, has established parks which are equipped with facilities for swimming, boating, and similar sports, as well as vacation cabins such as the one pictured here. Primary developments have been in connection with the Norris project with facilities concentrated at Norris Park, near the Dam, and Big Ridge Park, on the Reservoir. Similar, but less elaborate, facilities have been developed and are being planned, again in coöperation with other agencies, on the lower reservoirs. (Courtesy of State of Tennessee, Department of Conservation.)

ship to the lake. In addition to Chattanooga, there are three such communities —Dayton, Soddy, and Sale Creek, Tennessee (Figure 14). Each of these is at the head of a long embayment reaching west from the main channel toward the base of the Cumberland Plateau. The economic base of each community will be adversely affected to a greater or less degree by the loss of retail trade from inundated agricultural bottomlands. The possibility of obtaining new income from recreational developments on Chickamauga Lake, therefore, attains special significance in the case of these three communities. Studies were undertaken to determine in detail potential sources of such income and to make recommendations for a course of action which would take advantage of potentialities. Partially as a result of these studies, special local planning measures have been undertaken, sponsored by the state and counties, but aided by TVA. At Soddy, the county, state, and TVA are coöperating in the development of a small local park by WPA funds.

Following the pattern of demonstration parks built on Norris Lake by the TVA and coöperating agencies, six local, state, and federal agencies are coöperating to develop Harrison Bay State Park on the east shore of Chickamauga Lake —17 miles from Chattanooga (Figure 14). The TVA, National Park Service, CCC, Tennessee Department of Conservation, Hamilton County, and the

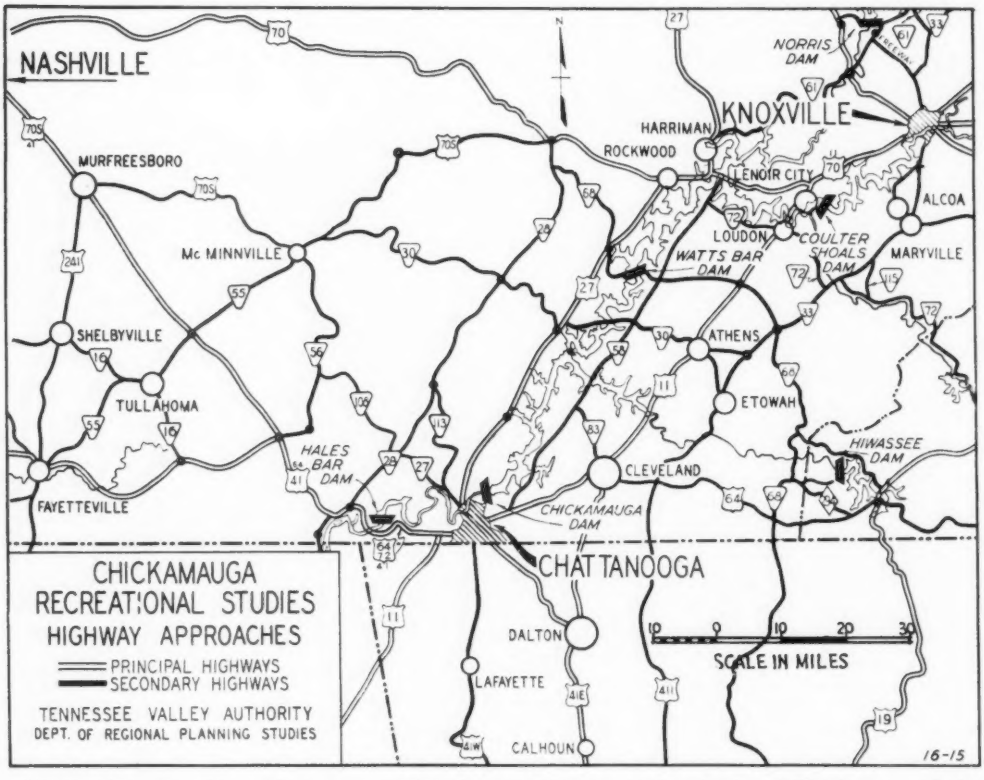


FIGURE 19.—Five federal highways will lead tourists along or to the vicinity of Chickamauga Lake. These and good secondary roads also will provide local urban and rural residents with nearby access to the lake shore. The prospective patronage moving over these highway approaches promises well for recreational developments along the lake.

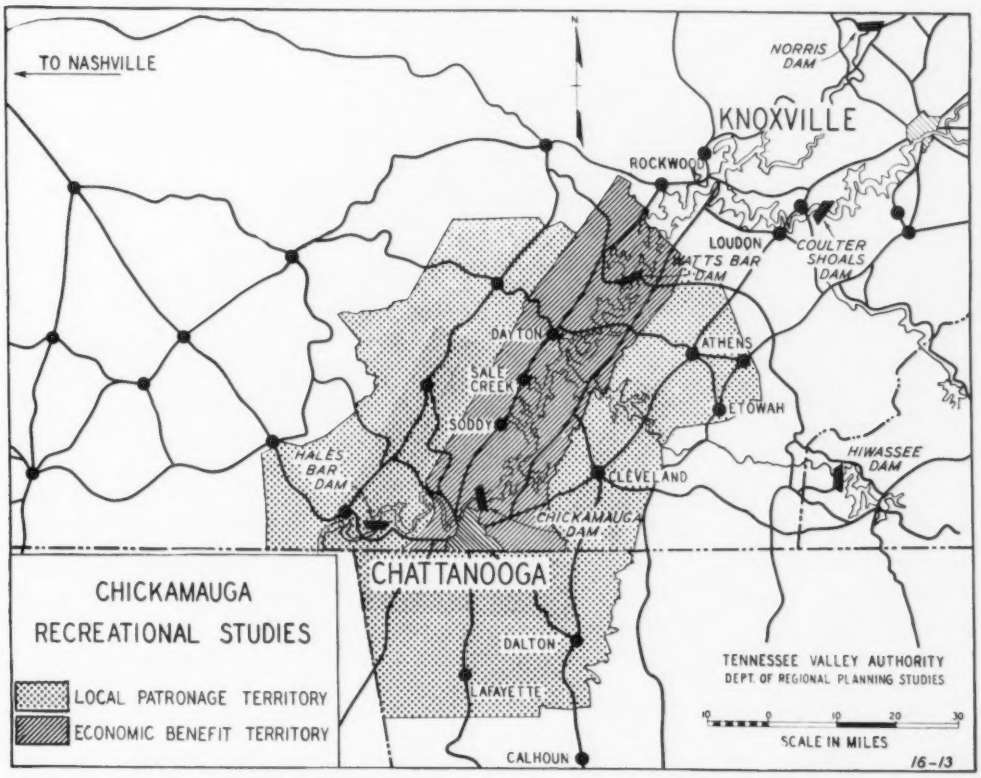


FIGURE 20.—The recreational facilities of Chickamauga Lake will be used by large numbers of people—both tourists and local residents. The greater part of the local patronage may be expected to come—as indicated on the map—from those areas within 40 or 50 miles of the lake via good roads. As a result of expected patronage, direct economic benefits of sizeable magnitude may be anticipated within the smaller shaded area, and indirectly, the benefits should have a much wider spread.

City of Chattanooga are combining their efforts to bring about this addition to Tennessee's growing state park system. The park is being built on land purchased by TVA for reservoir protection, its use as a park being a part of TVA's policy to place land so acquired into wise secondary uses. The park will be connected to Chattanooga by a divided freeway running through a 250-foot right-of-way, which will guarantee it against scenic encroachment. Nearer to Chattanooga than Harrison Bay Park and accessible from the freeway, another portion of the TVA reservoir protective strip is being developed as The Booker T. Washington State Park for Negroes. This park, though smaller in size, will have facilities similar to those in Harrison Bay Park and is being similarly sponsored. The parks will include a complete panel of outing park facilities —lodges, bathing beaches, boathouses, amphitheatres, vacation cabins, tourist camps, picnic areas, and several miles of hiking and bridle trails leading along the lakefront.

The final step in recreation studies of Chickamauga Lake will be the inclusion of all recommendations for recreational land use with those for other land uses, in a land-use plan for all Chickamauga properties. The method of preparing this plan will be outlined in Section Six.

Section Five

UTILIZATION OF FINDINGS IN THE APPRAISAL OF PROJECTS AND THE PLANNING OF READJUSTMENTS

Edward N. Torbert

ATTENTION in this section will center upon the organization of two different types of reservoir studies which incorporate materials discussed in the three preceding sections. The two types of studies are designed to help answer different questions which arise at different stages in a dam-construction program.

The first type precedes final decisions on the engineering specifications for a given project. The question to be answered is: What type of engineering plan is best suited for development of the section of river involved? Engineers propose alternative plans. The minimum and common requirement of these plans, in the case of main river projects, is that they provide a navigable channel of nine-foot depth throughout the year. The alternative plans differ, however, in cost, in relative advantages for navigation, flood control, and incidental power production. They differ also in their relative effects upon the economy of the area in which they are located. The study of the Land Planning Division deals with the last-mentioned point and involves a comparison of the alternative plans from the standpoint of their probable impact upon the local and regional economy. This, and studies made by other departments comparing the plans from other viewpoints, provide a basis for the Authority's appraisal and for decision as to which plan or its modification shall be carried out. Studies of these kinds are in progress, and only the outline of the approach by the Land Planning Division can be presented here.

Of basic importance are differences, under alternative plans, first, in the amount and quality of land to be displaced, second, in the number of persons to be displaced, and, third, in the size and depth of lakes to be created. To evaluate the social and economic implications of these direct physical changes, they are considered in relation to different types of units affected.

Three such types of units are recognized. The title of Reservoir Area is given to one (Figure 8). Local governments, represented by counties and municipalities, constitute the second (Figure 3). The third type is the trade area discussed in Section Three (Figure 15). The local governments are studied by another division of the Department of Regional Planning Studies. Coördination within the department of the findings on all three types of units makes possible a comprehensive appraisal of the impact of alternative plans.

Delimitation of the Reservoir Area is motivated by the need for a base against which can be compared the total probable effects of alternative plans. Logically, such a base should include all lands and people affected either adversely or beneficially by either direct or indirect means. The obvious impracticability of accurately delimiting such an area led to use of the boundaries shown for the three projects in the Knoxville-Chattanooga area. These are formed in part by county lines and in part by trade-area boundaries (Figure 8).

In comparing the probable effects of alternative plans, three points are of fundamental significance: (1) differences

in the lakes created, (2) differences in the land displaced, and (3) differences in the population displaced. A broad comparison of probable effects upon the economy of the reservoir area is first provided by the proportions of total land, population, and employment which would be displaced. This is followed by other comparisons of effects upon the productive activities of the area—agriculture, forestry, mining, manufacturing, and recreational service. In connection with each activity, alternative plans are viewed from the standpoint of the physical resources which would be added to or subtracted from the base upon which the activity rests. Also compared are the displacements in employment from each activity and re-employment problems and possibilities associated with the changed conditions. Agriculture is the only productive activity adversely affected to any great extent. As noted in Section Five, new opportunities are provided for recreational service. In summary, conclusions are drawn concerning the relative severity of the over-all problems which each plan would engender.

For the second of the three types of units considered—local governments—the most significant effects found are the reductions in tax base and in revenue caused by the retirement from taxation of property bought by the Authority. Analysis of these reductions in relation to financial status and service obligations leads to conclusions concerning the comparative effects of alternative plans upon governmental services.

In connection with trade areas, the procedure in analyzing probable effects of a single project upon the local commercial structure has been presented in Section Three. Alternative plans are analyzed in a similar manner and a comparison made of their probable effects. Qualitative conclusions result concerning the probable effects of alternative plans on these local economic units.

The second stage in the dam-construction program and the second of the two types of studies conducted by the Land Planning Division follow the decision on engineering specifications. After that decision is made, there can be established the immediate changes which will take place in the physical and cultural environment. Because of the imminent displacement of people and of resources upon which they depend, there arises the important question: What is the best practicable readjustment to the altered environment? It is to help

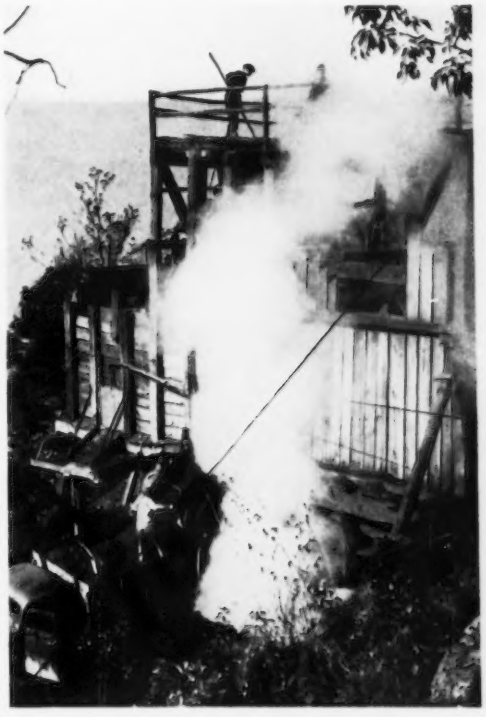


FIGURE 21.—Bituminous coal, outcropping on the face of the plateau escarpment, provided at an earlier time the basis for a mining industry important in the development of towns near the western edge of Chickamauga Lake. Coal mining on a relatively small scale is still carried on in a few localities. The tipple shown above, behind Dayton, is at the level of the mine mouth. In other cases the tipple is located on the valley floor, and the coal is lowered on an inclined railway in mine cars attached by cable to a donkey engine at the mine mouth.

answer this question that the second type of study is made.

The Chickamauga Project (Figure 9), now under construction, has been studied from this point of view. No previous study of alternative developmental plans had been made, so the nature and extent of the immediate problems to be created by the approved plan were first established by an analysis similar to that just outlined. Possible readjustments of both short-run and long-run nature which would offset adverse effects of the reservoir and effectively utilize resources of the area were then investigated from two viewpoints: that of the productive activities of the reservoir area and that of the affected communities. An example of each will be presented.

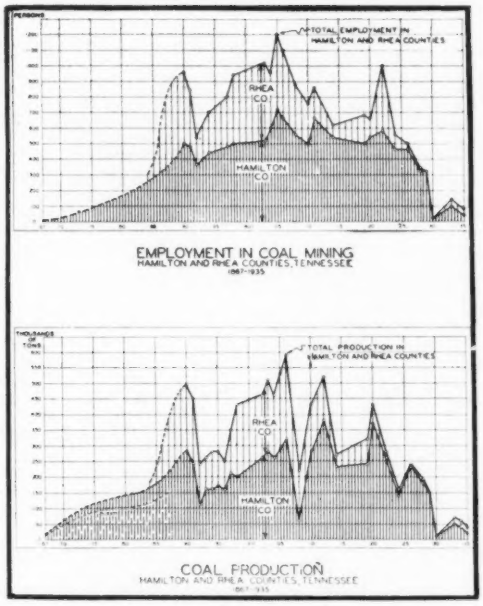


FIGURE 22.—The coal fields of Hamilton and Rhea counties, for which data are shown here, are largely within the Chickamauga Reservoir Area. Both coal production and employment in coal mining in this area had fallen, by 1932, from peaks reached in the early part of the century, to levels of the period 1867–70. Although there seems little promise of a return to the former high levels of production, which were supported by blast furnace operations now abandoned, some advance from the present low levels is in prospect.

Bituminous coal mining (Figure 21) offered an intriguing field for investigation because, although the activity is of minor importance today, much of the coal remains, outcropping on the face of the plateau escarpment west of the river, and the industry once was of major importance. From peaks in the early part of this century, both employment and production in the coal fields of Hamilton and Rhea counties which are largely included in the Chickamauga Reservoir Area had fallen to relatively insignificant levels by 1932 (Figure 22). The market which supported the industry in the past was largely that provided by blast furnaces, charged with local iron ore, coke, and limestone, at Dayton, Rockwood, Chattanooga, and other towns at the foot of the escarpment (Figure 8). The last of these furnaces to operate was closed at Rockwood early in 1930. Revival of the iron industry in competition with the nearby superior resources and superior equipment of the Birmingham, Alabama, district seems extremely improbable. The remaining local coal market is limited, but is growing, and the availability of water transport will extend the potential market area. In this latter connection, however, the Tennessee fields in general are at a disadvantage inasmuch as a partial ring formed by the competing fields in the Birmingham district, in western Kentucky, and in eastern Kentucky, Virginia, and West Virginia separates the Tennessee fields from the major markets of the nation. Even among the Tennessee fields those of the Chickamauga Reservoir Area are at some competitive disadvantage. A number of conditions operate to make production costs in the southern Tennessee fields somewhat higher than those in the northern Tennessee fields. Hence, although there are no grounds for anticipating a

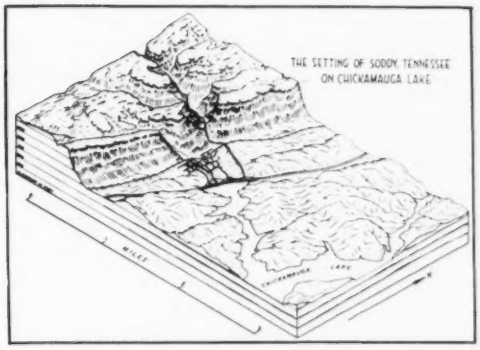


FIGURE 23.—Soddy, Tennessee, has a very favorable location for recreational developments. It will lie at the head of one of the more attractive and larger arms of Chickamauga Lake. Behind the town rises the escarpment of the Cumberland Plateau. The wooded surface of the plateau and the views from its margin across the lake will complement the recreational attractions centering in use of the water.

return to the former high levels of production, some improvement from the present level of activity is in prospect. To aid development, the Authority anticipates provision for adequate river terminal facilities at strategic sites. Within the Chickamauga Reservoir Area a public terminal is contemplated near Dayton.

Turning to Soddy, formerly a coal-mining town, it was found that through displacement of trade-area residents the volume of retail trade from present sources may be reduced 10 per cent (Figures 10 and 15). About one-fifth of all lands used for agriculture and about half of the best farm lands in the trade area will be purchased by the Authority. Land-use problems already exist on portions of the area which will remain after the reservoir is filled. A portion of the town of Soddy will be flooded, and many residents who work in metropolitan Chattanooga will probably, when displaced, move from Soddy to Chattanooga. To prospective trade losses must be added the unfortunate fact that Soddy is at present losing importance because it occupies a poor position for trade competition with neighboring towns. Moreover, a large percentage of the town's residents, former coal miners, are on relief. In short, serious problems which now exist will be considerably aggravated by creation of the reservoir.

Among possible lines for readjustment, recreational development appears promising. The town will lie between the head of a large and attractive arm of the reservoir and the plateau escarpment (Figure 23). To the top of this a new road from Soddy provides easy access. The town is only 20 miles from the urban population of Chattanooga, and a major tourist route will cross the head of the embayment in front of the town.

Recognition of the problem and the recreational possibilities forwarded steps which should facilitate the readjustment. Efforts of the Community Planning Division of the Department of Regional Planning Studies have been directed to the end that land purchases at the reservoir margin of the town, the character of waterfront improvements, the design of the dike carrying the highway across the embayment head, and like considerations shall provide the optimum physical conditions for recreational developments. Because of the comparatively acute relief problem, aid of the Tennessee State Planning Commission has been enlisted in a coöperative State-TVA project at Soddy. Here a field representative of the Planning Commission is working with citizens to ensure that the opportunities are grasped and made of advantage to the community. Through efforts along these and other lines, it is anticipated that not only will the adverse local effects of the reservoir be offset, but that a sounder adjustment than now prevails will be established.

Section Six

DETERMINING THE PURCHASE BOUNDARIES AND THE USE OF RESERVOIR PROPERTIES

Christian C. Crossman

IT was noted earlier that when the Tennessee Valley Authority builds a dam it buys land for the reservoir itself and, in addition, for a protective strip around the reservoir. The discussion here covers the procedure developed in the Authority to assure the complete coördination of work pertaining to the establishment of purchase boundaries for these reservoir properties and the use and management of these properties after they are purchased. The function of the Land Planning Division with respect to these activities is primarily one of appraisal and coördination.

There are twelve departments in the Authority—most of them concerned with problems of planning—that have special technical responsibilities in the procedure to be discussed. For example, the Department of Forestry Relations is responsible for an integrated forestry and wildlife program, which is dependent, in large measure, on the use of Authority-owned land around all of the reservoirs. The Design Department, among other activities, plans the relocation of roads flooded by the reservoirs and is thus concerned with the acquisition and the present and future use of reservoir lands. The responsibilities of other departments are as singular and as diverse as those indicated in these two examples. The unifying elements in interdepartmental activities are a common theater of interest (single reservoir areas) and a common objective (the effective utilization of reservoir lands). The procedure adopted by the Authority is a means of assuring proper coördination of effort and materials and, at the same time, equal opportunity for each technical agency to make its contribution.

The procedure consists of seven steps, the first of which is the simple one of delimiting in a preliminary way the area which is to be the theater of activities—that is, the area in which prospective land purchases will be made. In this connection, aerial mosaics showing ownership, property lines, and reservoir contours are sent to the Land Planning Division by an engineering division for use in subsequent steps.

The second step is primarily a responsibility of the Land Planning Division. It consists of two lines of work. The first is directed to providing an understanding of the regional setting of the reservoir area and involves a reconnaissance survey of the local region, covering such points as land conditions and uses, local economy, and sources of employment, habits of trade, and patterns of transportation. Results are transmitted to other departments in the form of a report consisting of text, maps, graphs, and pictures. The second line of work is directed to providing basic data for use in later departmental studies and involves a detailed survey of the reservoir area with particular attention to the land between the normal pool contour and the upper limits of the prospective purchase area (Figure 24). This survey covers for this critical area items similar to those covered in the reconnaissance survey but on a more detailed scale. Information is plotted on maps which carry, in addition to the

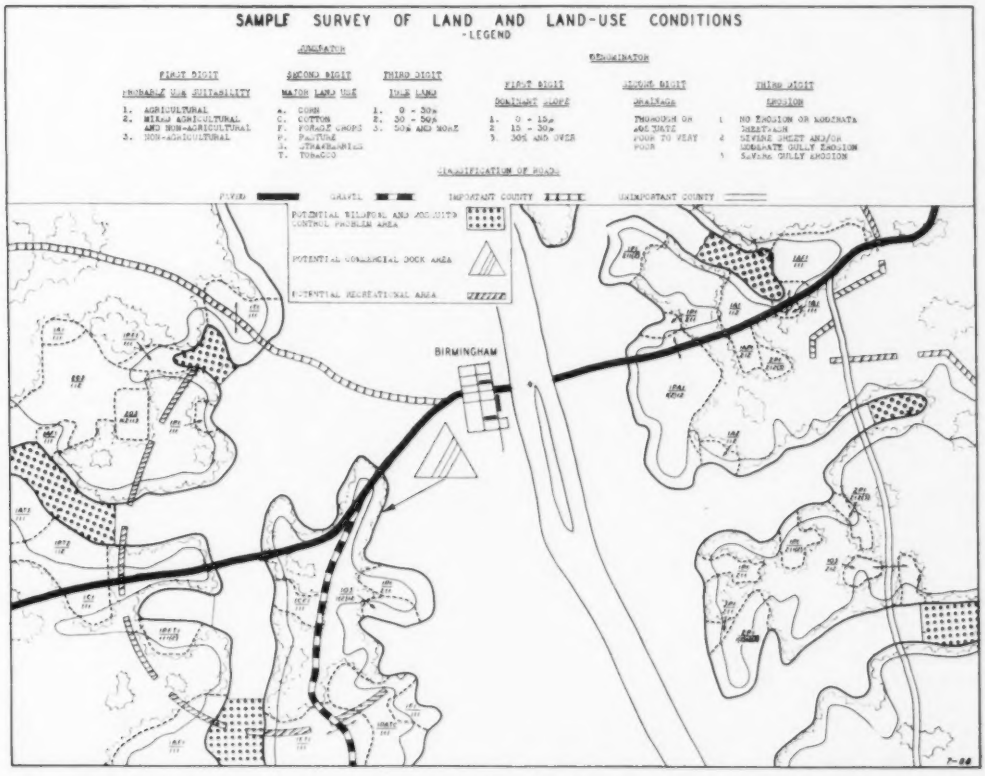


FIGURE 24.—Reservoir purchases include land to be flooded and an adjoining protective strip. The amount of land to be purchased, and the use of the properties after purchase require inter-departmental considerations of, among other things, land and land-use conditions. Data covering these factors are procured in the field by the Land Planning Division and transmitted to other departments for use in their technical studies. This map, taken from the Gilbertsville Reservoir Survey, represents a portion of one of the several maps prepared by the Land Planning Division for this use. A careful study of the legend and the field notes will reveal the types of data which, from experience, have been found to be of prime utility.

usual cultural data, details as to property ownership and property lines so that the field information can be considered in relation to individual properties. These maps, together with answers to specific questions raised by individual departments, constitute the material results of the survey.

In order to insure the inclusion of all essential information and in order to eliminate the inclusion of non-essential information, conferences are held with all coöperating departments prior to the inauguration of both surveys. At these conferences the specific needs of each department are determined in detail, and on the basis of these needs are the surveys designed. Some of the information which is requested requires the presentation for the entire prospective purchase area of basic data, such as the distribution of slope, erosion, and drainage conditions. On the other hand, some requests necessitate the delimitation in the field of specific problem areas that are the particular concern of individual departments. To illustrate, the Health and Safety Department requested for the Gilbertsville Reservoir the delimitation of mosquito-control problem areas, examples of which appear in Figure 24. Always with respect to such requests definite instructions as to criteria for determining problem areas are provided.

For instance, with respect to delimitation of mosquito-control problem areas, instructions were given to indicate on maps the boundaries of extensive areas where, during the mosquito-breeding season—that is, the spring and summer months—the depth of water after impoundage will be less than five feet.

With data from the reconnaissance and detailed surveys in hand, each department proceeds with Step 3 activities. Responsibilities here consist of technical departmental appraisals in the field and in the office of the factors which must be considered in recommending purchase boundaries for the areas of special concern and for recommending at a future date the uses of the land in these areas. When these studies are complete, recommendations which take the form of reports and maps are transmitted by the departments to the Land Planning Division for coördination —the fourth step in the procedure. In the process of this coördination the Land Planning Division reviews and summarizes the recommendations that are made with respect to purchase boundaries; and, where coincidence in recommendations does not occur, the division holds conferences with the interested departments for purposes of obtaining mutual agreements on single boundaries.

All recommendations concerning purchase boundaries, together with the supporting statements, are then transmitted to the Maps and Surveys Division of the Water Control Planning Department through an interdepartmental committee of review. The Maps and Surveys Division in Step 5 considers these matters in conjunction with factors of an engineering nature. Final recommendations concerning the location of purchase boundaries determined by the Maps and Surveys Division on the basis of these two bodies of engineering and non-engineering materials are transmitted through the General Manager's office to the Board of Directors for approval. Purchase in reservoir areas follows such approval.

The last two steps in the procedure—Steps 6 and 7—are taken when property purchases are nearing completion—in most cases after a matter of several months. These steps are concerned with developing plans for the use and management of reservoir properties, respectively (Figure 25). In developing land-use recommendations, planning departments utilize the survey materials of the Land Planning Division provided under Step 2 as well as their own survey materials gathered under Step 3. Recommendations developed are submitted to the Land Planning Division for appraisal and coördination. Some of the recommendations are aimed at the solution of problem conditions. For example, the Health and Safety Department submits plans for land required for mosquito-control operations in areas where conditions are of a problem nature. The plans submitted by the Department of Forestry Relations include the reforestation of badly eroded lands. Other recommendations are directed to the use of lands which do not present problem conditions—for example, the Department of Agricultural Relations submits recommendations for the use of agricultural lands, developing these recommendations in coöperation with local farmers. The Department of Regional Planning Studies submits plans for recreational uses of lands unique in their scenic or recreational potentialities. In most cases the coördination of recommendations can be accomplished with relative ease because most areas are sufficiently unique in character to eliminate conflicting plans for their use. In a few cases, however, conflicting recommendations may be submitted for the

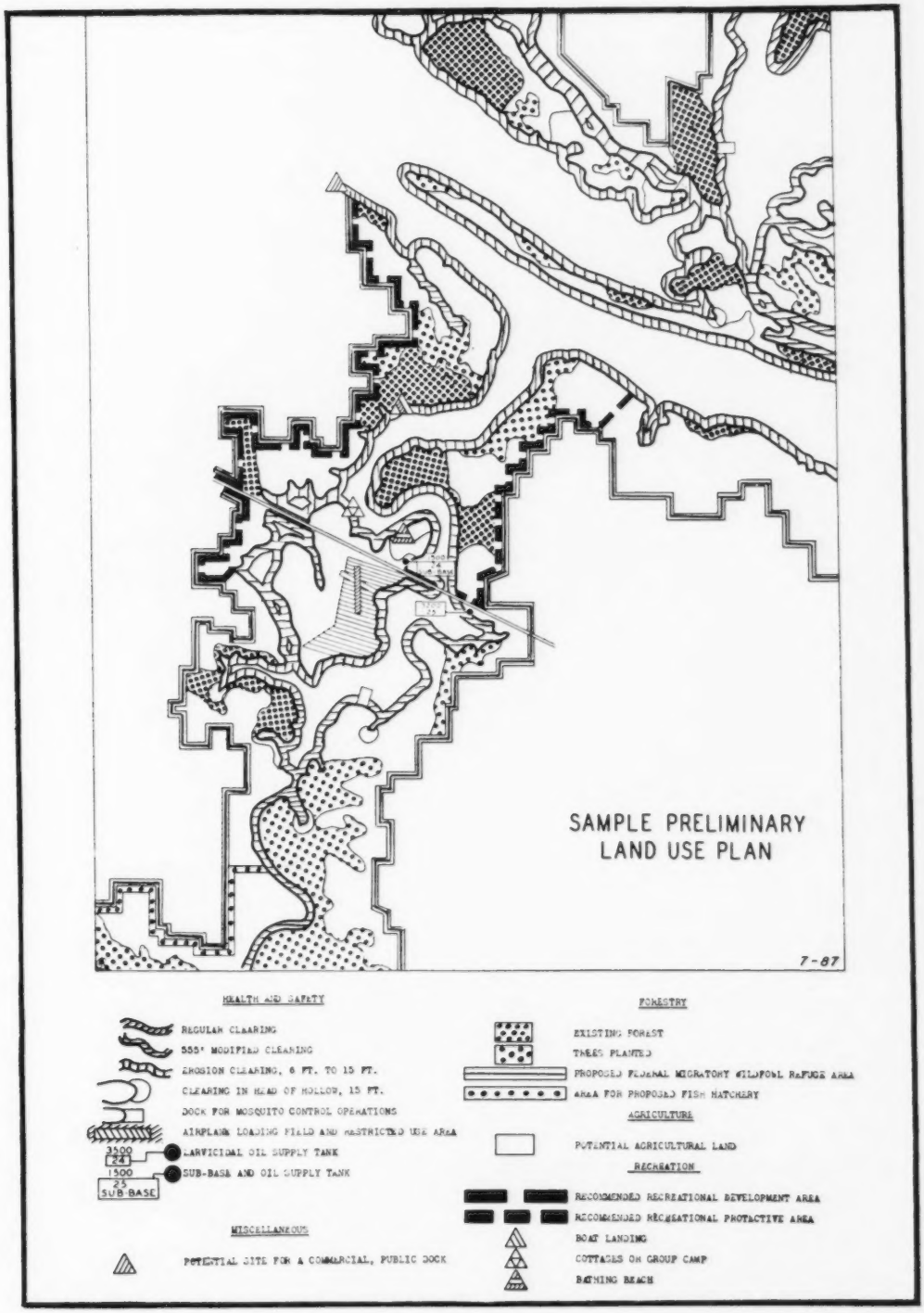


FIGURE 25.—On the basis of data covering land and land-use conditions (Figure 24) and their own technical studies, coöperating departments submit to the Land Planning Division recommendations for use of reservoir properties owned by the Authority. This sample taken from a land-use plan now under consideration shows types of recommendations and how, after being appraised and coördinated, they are put in final map form for use by the Department of Reservoir Property Management.

same lands. Under these circumstances, necessary office and field studies are made by the Land Planning Division together with representatives of the departments concerned to the end that one coördinated body of recommendations can be developed. The embodiment of these recommendations into a master land-use plan completes the work under Step 6.

The last step calls for the application of the land-use plan after Board approval. This application is a matter of management, which is the responsibility of the Department of Reservoir Property Management. This step is, of course, a continuing one, requiring revisions in the original plans as new conditions develop and specific problems of management are met. In this process the Land Planning Division continues to act in a coördinating capacity, assisting in the incorporation of revisions in the original plan.

Section Seven

MEETING REGIONAL PROBLEMS AND NEEDS

Victor Roterus

THE emphasis of the preceding sections has been on the contributions of geographic techniques and analyses to the problems confronted in the river-development program. TVA's primary emphasis has been on this program and its related construction activities. The Act creating TVA, however, gives the Authority a broader responsibility of planning for, and assisting in, the general development of the watershed region. Hence, geographic studies have been directed not only to serve the river-development program, as has been discussed, but also to serve the broader regional program of economic and social betterment.

For the river-development program, fortunately, many thoroughgoing and competent surveys had been made under successive Congressional appropriations years before the creation of TVA. The ground had been well broken, and the field was familiar. Development could begin immediately. However, there existed no surveys, no body of correlated data on the broader aspects of the region comparable to those of the army engineers on river development. Hence, before a definite and complete program of regional planning effort could be formulated, there was a great deal of exploratory work to be done. What does this watershed region need in order to develop? What critical factors are preventing the fulfillment of these needs? By what methods can the region be most effectively assisted in meeting these needs?

These questions, here simply put, involve rather large orders. Many of the needs of the Valley were immediately apparent, and programs were launched to meet some of them. That soil erosion had been steadily shrinking the productive capacity of the agricultural lands of the Valley has been long-known. Many devices such as contour plowing, terracing, and planting of leguminous cover crops, applicable in other areas, were applicable in the Valley. Further, Congress had instructed the TVA to use the war munitions plants at Muscle Shoals during peace times for the experimental manufacture of fertilizer (Figure 26). Through and in coöperation with land-grant colleges, this fertilizer is distributed to farmers for demonstrational purposes. This distribution is made under contractual agreements designed to insure

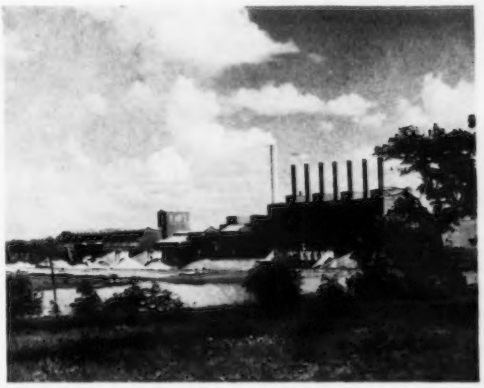


FIGURE 26.—Munitions Plant No. 2, Muscle Shoals, Alabama, which has been geared to the experimental production of phosphate fertilizer during peace times. The transportation savings effected by a highly concentrated fertilizer plus low cost methods of production enable more widespread use of fertilizer. Shown here is the equipment for receiving phosphate rock, silica, and coke.

adoption of proper soil-conserving practices. The farmer also agrees to keep accounting records in order that the economic feasibility of these demonstrations can be determined. Even in this program there remains a necessity for more planning effort. These farm demonstrations will be successful if they are proven economically feasible and more so if they are adaptable to significant portions of other farm lands in the Valley. In order to insure that the demonstrations are practical and have widespread applicability, standard soil surveys in which the Authority coöperates with the U. S. Department of Agriculture are being made. Using this and other work as a basis, the demonstrations can be rationally keyed in type and in volume of location to the varying conditions of types of farming, erosion, soils, and slope existing throughout the Valley. Similarly, soil surveys in conjunction with other findings contribute to such measures as the retirement of lands unsuitable for agriculture into other uses by means of zoning laws or public purchases. In the initiation of such a program in Hamilton County, Tennessee, the survey work has been particularly useful.

The soil-conservation program was launched comparatively early in the Authority's existence. Meanwhile, the Valley's economic and social needs were explored. In this research activity, analysis of rural-land-classification-survey data and analysis of the relationships existing between the major livelihood activities of the Valley played a part. As the facts and relationships concerning needs became apparent, it was possible to define more clearly planning objectives and to provide for these needs in the regional program.

FIGURE 27.—Farmers in the Tennessee Valley inspect a field of oats seeded through lespedeza sod with the new furrow seeder developed by TVA in coöperation with the University of Tennessee. An instance of how TVA in coöperation with State Agricultural Extension Services is attempting to make practicable the adoption of soil conservation practices by farmers through experimentation and demonstration of new equipment adapted to local conditions.

Some of these facts have already been noted in a preceding section of this series. It was shown that such economic indices for the Valley as per capita spendable income, net farm income, average annual wage and per capita retail sales are strikingly low when compared with figures for the nation—lower even than in the South as a whole. Behind these facts are others. Much of the Valley's agriculture is in a depressed

state, and its foundation—the soil resource—is deteriorating (Figure 6). The Valley has considerably less manufactural and service employment relative to total employment than has the nation. The dominantly rural character of the Valley and the unfavorable conditions under which farming is attempted in many places account largely for poor public services—such as schools, health, distribution of electricity. Yet, unless the economic status of the Valley is improved, the people of the Valley cannot afford to expand or improve these services significantly.

Hence the major goal of any regional program for the Valley must be to raise the economic level or real income of its people and to insure a proper distribution of these benefits.

To achieve this general goal, it has been found, through the experiences of five years, that certain fundamental adjustments are necessary in the Valley. The first major adjustment is to make the long-term benefits of soil conservation compatible with the farmer's immediate income needs—and in the Valley, it must be remembered, these needs are particularly acute and compelling. Income from farming is low compared to some of the other major occupations and even when compared with farming in the remainder of the nation. To enable the farmer to make the shift to soil-conserving practices at least without penalizing his immediate income and with good likelihood of increased income, certain measures have been adopted. These include experimentation and demonstration with new agricultural equipment adapted to local conditions, methods and equipment for processing products on and off the farm, and improved marketing tools and techniques (Figures 27 and 28). But soil conservation, in itself, is not enough. Indeed, since in some phases of soil conservation less intensive use of the land is implicit, there is a need for coincident adjustments in fields other than agriculture. This need is further accentuated by the adoption of the more stringent measures such as rural zoning or public acquisition of land for forest, park, and other non-agricultural uses since these measures have, despite their long-run benefits, the immediate effect of displacing agricultural population and thereby contributing to the burden on the remaining agricultural lands. TVA's purchase of reservoir lands, removing them from agricultural production, further adds to the immediate problem. It would seem, therefore, that only part of the problem of reconciling soil-conserving practices with farm income can be met within the domain of

FIGURE 28.—A "walk-in" community refrigerator developed by the University of Tennessee Engineering Experiment Station in coöperation with TVA. This refrigerator, simply constructed and operated as a demonstration unit by a group of farmers in Knox County, Tennessee, permits the farmers to maintain basic diets. Products which formerly had to be disposed of immediately can now be stored and consumed as needed by the persons who grew them.

agriculture itself. To insure the success of a soil-conservation program and at the same time to raise the economic level of the Valley as well, opportunities for employment in the industries and services other than agriculture must be augmented.

It has been found that the greatest immediate promise of such employment expansion rests, not exclusively, but largely, in two industries—manufacturing and recreation. TVA's water-control program in itself, through the creation of power relatively low in price and of a navigable waterway, has been instrumental in some expansion in manufacturing (Figure 29). Three reputable chemical concerns have already established branch plants in the Valley, and plans are underway for the construction of an electro-metallurgical and an electro-manganese plant. Research has disclosed that only in these industries—the electro-chemical and the electro-metallurgical—and in another, the paper-pulp industry, are power costs a prime locational factor. However, the introduction of power relatively low in price and a navigable waterway, through association with the other resources, have enhanced the value of these other resources. For example, one of the plants mentioned uses large blocks of secondary power and phosphates. Before the power was available and juxtaposed with the phosphate resource, the latter resource in itself was not attractive enough to encourage the establishment of the industry. TVA's research on interterritorial freight-rate differentials existent in the United States has lent force to efforts to bring these differentials toward closer parity and in so doing remove one of the artificial barriers to manufactural development in the South. Another research study pointing out how the steel industry's basing-point price system has stunted the growth prospects of the Birmingham district and southern

FIGURE 29.—Stern wheeler and barge going upstream through locks at Wheeler Dam, Alabama. The TVA program, as yet uncompleted, calls for a year-round, nine-foot channel in the Tennessee River from Knoxville, Tennessee, to the Ohio River.

steel fabrication in general may have been a contributing factor in bringing about recent improvements in that price pattern.

Geographers, in coöperation with other professional groups in the TVA, have analyzed existing industry trends, have offered opinions on such problems as whether or not construction communities should be built on a permanent basis in light of their future functional prospects, and have gathered and recorded pertinent information in response to inquiries concerning industrial locations. The possibilities inherent in the Valley's mineral resources are also being explored by qualified technicians in the Authority.

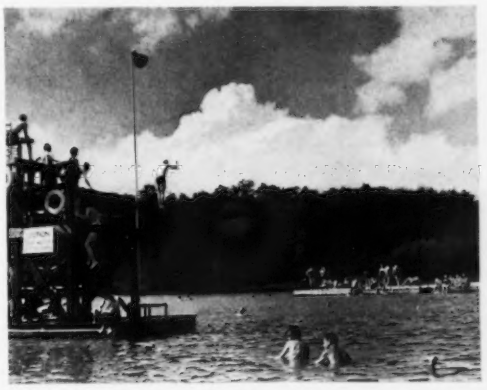


FIGURE 30.—In coöperation with existing park agencies, TVA is demonstrating proper standards for developing the recreational resources of the Valley. The development here pictured is on an arm of Norris reservoir and includes cabins and other structures not shown in this view.

The recreational industry also promises immediate and eventual relief to the Valley's chief economic problem of unbalance. The inventory of the Valley's recreational resources and publication of that inventory—both implemented largely by a geographer consultant—and other work of that nature have already been discussed in Section Four. Tangible recreational developments are already in evidence, and plans in conformance with greater growth are being coöperatively made with state and local agencies (Figure 30).

On the theory that the expansion of employment opportunities in the industries other than agriculture must be properly guided if it is to be enduring and in the best interests of the general welfare, research on this phase of the problem has been engaged in. Chaotic development is taking place in towns which are in key positions not only to benefit themselves from recreational development but to set standards for the entire region. These towns are being stimulated to make improvements and adjustments to aid rather than to hinder proper future growth. Conditions of urban industrial unbalance are being studied. These conditions include analysis of specific towns to discover such items as an unwholesome preponderance of female employment over male employment (a common condition in textile centers), a too great reliance on light industry with its concomitant condition of relatively low wages, a too exclusive dependence on extractive industries with their threat of extinction, and a future intimately related to a tributary area whose agricultural lands are deteriorating. The results will probably be made public through state planning boards and local organizations in order that the communities themselves can begin to provide for adjustments.

The attempt has been made here to give the flavor, rather than a complete picture, of the efforts toward regional development by the Authority and, more particularly, by the Land Planning Division. The TVA is admittedly a regional experiment. It is an experiment in more ways than one. As has been implied, various professional viewpoints —and various techniques within those viewpoints—are being put to a realistic test, measurable in terms of regional betterment. In a sense, the Valley thus

constitutes a proving ground for regional sciences. The completion of TVA's river development program will meet many of the Valley's specific needs and will aid adjustment to the Valley's broader regional problems. Eventual adjustment, however, will be at best a slow and unspectacular process demanding realistic and purposeful efforts by the various sciences and by representative public and private agencies acting in reasonable concert.

WATER IN THE LARAMIE REGION OF WYOMING

Carol Y. Mason

IN Laramie, Wyoming, both wind and water are important, the one, for its abundance, the other, for its scarcity. Up on the mountains not far distant, wind-swept spruces take fantastic forms (Figure 1) as strong winds from the west blight the buds and prevent growth of branches on one side of the trunk; down on the plains ranch folk of early days built their homes partly below ground, perhaps because the dry earth made this conveniently possible, but, as some think, also to avoid the full sweep of winter winds. Many old ranch houses still have the main floor built slightly—a few steps—below the level of the ground, as one finds upon entering. In Laramie, as in other cities of that part of the country, the old custom is reflected in some of the modern buildings. Figure 2 shows a home on the outskirts of the city, where the family live comfortably in what may ultimately be the basement of their house. Throughout the city, basements are dry and well lighted, and contain finished rooms in which people live. Often these are rented apartments, as comfortable as those on the upper floors and in some cases almost as expensive.

Laramie, Wyoming at an altitude of 7,100 feet, graces the Laramie Plains with mountains rising to the east, west, and south, to altitudes of 8,000 to 12,000 feet or more. The city was founded in 1868 by the Union Pacific Railroad, of which the yards and shops (Figure 3) still employ more people than any other industry in the locality. The city is a division point on the main transcontinental line. Dozens of freight trains pass through day and night. In 1934 more than 6,500 cars of cattle, sheep, and horses were fed as they freighted through to eastern markets, in addition to the many cars of animals shipped from Laramie itself. Great passenger trains between Chicago and the Pacific Coast form an important part of the traffic, and modern "Streamliners" are familiar to all who live within sound or sight of the road. At the opposite end of the town from the railroad lies the campus of the University of Wyoming, a second center of activity with a transient population of more than a thousand students.

Laramie as a whole (Figure 4) has a population of more than 10,000. Its shady streets form an oasis in the treeless plain. Its twinkling lights and floodlighted tall chimneys guide transcontinental airplanes at night. On

FIGURE 1.—Spruce trees on exposed upper slopes of the Medicine Bow Mountains. Strong winds have prevented growth of branches on the windward side.

the parched brown grassland of the surrounding country, where can sufficient water be found to support a city? Scarcity of water is truly the problem for the entire region. In only one way does Laramie sometimes get more water than it needs. When torrential rains pour down upon the Laramie Mountains, which lie only five

FIGURE 2.—Basement house on the outskirts of Laramie. Finished rooms in basements are a survival of the custom of pioneer building partly below ground because of the strong winds which sweep across the plains.

miles east of the city, a sheet of water which sometimes rolls down the slopes, formerly inundated streets and basements of the unprotected settlement lying in its path. In recent years, however, a flood-protection channel has been dug at the base of the mountains, which parallels the highland and catches the run-off, carrying it into a small stream valley in which the channel has been enlarged to divert the water around the city rather than through it. Figure 5 shows part of the channel, at the point where the Lincoln Highway bridges it on the route to Cheyenne.

Aridity is the great problem of the Laramie area. The grassy plains are underlain by alkali at very shallow depths (Figure 6) and in many places alkali lakes form on the surface, where there is no drainage through to the river. Some industries, such as the United States Gypsum Company (Figure 7) which mines gypsite from the plain within a mile of the plant, take advantage of the presence of minerals which would have been dissolved out in a more humid climate, but to most occupations lack or scarcity of moisture is a disadvantage.

Laramie receives on the average, 11 inches of rain yearly. In the 40 years from 1891 to 1930 the driest year had slightly less than 4 inches and the wettest slightly more than 15. Most of the precipitation is in form of convectional showers of short duration, 60 per cent of the moisture falling between the first of April and the first of September. The average annual snowfall is 45 inches, much of which evaporates directly, contributing no

FIGURE 3.—Railroad yards of the Union Pacific at Laramie. The railroad founded Laramie and is still its most important activity.

water to the soil. Because of high winds and rapid evaporation the grassland lies uncovered nearly all winter, and cattle and sheep graze there through out the year. There are on an average only 61 days during the entire year when cloudiness is so great that the sun shines less than 30 per cent of the time. With the intensity of insolation at high altitudes, the sun feels very warm during the day, and on some summer days the air itself becomes quite warm, though no temperature higher than 92 degrees has ever been

recorded there. At night, however, and during the winter, the dry air cools rapidly and the average diurnal temperature range varies from 21.6 degrees in January to 28.7 in September. Temperatures ranging from around 50 degrees at night to around 80 degrees during the day are frequent in summer, while temperatures from 10 degrees down to zero and below are not uncommon in winter. During the 40 years of record at the University weather station freezing temperature was at some time recorded during every one of the twelve months of the year, and the growing season varied from 71 to 152 days. Thus crop growing is hazardous because of frost danger, as well as being impossible without irrigation.

Vegetation of the Laramie Plain is short grass, upon which many animals find pasturage. Figure 8 shows a herd of horses grazing near the city. Ranches are large, containing many thousands of acres. Hereford cattle, sturdy enough to withstand the rigorous winters without shelter, are raised almost exclusively. The grass cures during the summer in standing hay which is important during the winter months, but which is frequently supplemented by hay cut from irrigated meadows and hauled out onto the range. On the elevated lands of the mountain slopes, where drainage is more rapid and vegetation more sparse, sheep graze during the summer, and the lonely sheep herder's wagon (Figure 9) seen from long distances, gleams like a white dot on the mountainside.

FIGURE 5.—Lincoln Highway crossing flood control channel east of Laramie. The channel catches run-off from torrential downpours on the Laramie Mountains and prevents inundation of streets and basements in the city.

The lot of the schoolteacher who secures a job on the Wyoming range is lonely. In the early days, some schoolhouses, like the sheep herder's wagon, were built on wheels and remained at one ranch while there was a child of school age, but later moved to another ranch where another child needed schooling. Thus did lack of water, with its attendant remoteness of homes on enormous tracts of land, indirectly affect school life. In 1937 in Albany County in which Laramie is situated, there was one trailer school, while there

FIGURE 4.—Laramie, Wyoming, in the heart of the Laramie Plains.

were 16 schools having one pupil each, and 12 schools of two pupils. Great distances still make consolidated schools impractical.

The log schoolhouse shown in Figure 10 is in a region where a large irrigation ditch has caused several ranches to center about the wetter land, and the teacher has enough pupils for a substantial permanent building. Yet even here the treeless plain stretches for miles to the horizon, and in some such schoolhouses each child brings a bottle or a can of water to drink each day, while the teacher provides a gallon to be used sparingly for washing hands after lunch. If the school be near a stream, that water may be used for washing, but otherwise the scarcity of supply makes the teaching of hygiene as well as its practice a difficult matter, largely a matter of precept rather than example. In 1937 a demonstration was given, of 20 children washing their hands with only one quart of water. A thick soap lather was formed, and a few drops of water afterward sprinkled on the hands of each child, to wash the lather off. How different the teacher's problem here, from that in a region where rain provides plenty of drinking water and a garden to beautify the school yard.

FIGURE 6.—White alkali beneath three inches of soil. Short grassland of the Laramie Plains. In low places alkali is at the surface, on better drained sections it is deeper.

FIGURE 7.—Plaster mill of the United States Gypsum Company, Laramie. Raw material, a soluble mineral deposited under arid conditions, is mined from the plain within a short distance of the plant.

In Laramie itself, the monotonous treeless plain gives way abruptly to the varied pattern of irrigated trees and lawns (Figure 11). The Laramie River (Figure 12) which flows through the western part of the town, has considerable importance, but is not the source of water for the urban population. Each spring the Union Pacific Railroad brings thousands of ties from the mountains, floating them down the river in the great "tie drive." The ties are treated at Laramie and used on the roadbed from Omaha and Kansas City to Ogden, Utah. The river also yields thousands of tons of ice which the Pacific Fruit Express Company at Laramie cuts every winter, both on the river itself and on a small pond into which the river is diverted. The long sheds in which an entire train is iced at one time, and the great storage ice house behind it take care of thousands of cars yearly and are said to be the largest natural icing plant in the United

States. The river itself is too shallow for swimming, but recently a pool has been excavated near it (Figure 13) where Laramie children swim all summer.

Miles above Laramie, where the Laramie River emerges from the mountains, a large irrigation ditch like that shown in Figure 14 branches from the river and carries water at a higher level than the main stream for a long distance. Laterals from this furnish water for many acres of irrigated hay, and such crops as alfalfa (Figure 15) and some small grains. In many cases a little irrigated land is the nucleus about which a great ranch is built; in other cases vegetables from smaller plots of irrigated land provide fresh products for Laramie. For the most part, however, it is irrigated lands of Colorado which ship vegetables to Laramie markets. The region around Laramie is fortunate to have such a water supply, as many ranches in Wyoming have only enough water for the stock and for domestic use, with no possibility of irrigation, a situation which makes fresh vegetables almost unknown to their tables. But the very presence of irrigation water creates problems as well as advantages, and even today feuds rage over water rights, as distribution of water forms a serious and often controversial problem.

FIGURE 9.—A sheep herder's wagon on the gentle west slope of the Laramie Mountains. Sheep bedded down for the night in the foreground have in time killed some of the vegetation. No sheep in picture.

Laramie is a beautiful city of shaded streets (Figure 16) and attractive, comfortable residences. Its university campus is beautified by many trees, and new structures such as the Liberal Arts Building (Figure 17) have much artistic planting around them. In early days of the city, when great effort was made to raise trees where none had been before, importance of trees was so great as to warrant a special section in the

FIGURE 8.—A herd of horses grazing on the short grass of the Laramie Plains, not far from the city. The treelessness and low eminences of the plain are characteristic.

FIGURE 10.—Log schoolhouse 35 miles from Laramie. To many such schoolhouses on the treeless, waterless plain school children must carry their own drinking water each day.

city ordinances. The law regarding them in 1900 read as follows: "Any person who shall tie any horse, mule or other beast of burden to any growing tree within the limits of the City of Laramie without permission of the owner of said tree, shall be fined in a sum not exceeding twenty dollars, upon conviction before a police justice of the City of Laramie; and any person who shall wilfully, without permission of the owner, destroy or mutilate any growing tree in said city, shall be deemed guilty of malicious mischief and upon conviction thereof, shall be fined in a sum not exceeding fifty dollars." Today trees are carefully tended and irrigated. Along some streets every tree, large and small, has a hollow tile inserted in the ground near the trunk (Figure 18) through which water may penetrate nearer to the roots. In other cases, as shown in Figure 19, a mound of earth about the trunk holds water.

The commonest method of irrigating lawns and trees in Laramie, as in most cities, is with hose and sprinkler (Figure 20). Many are attached to a silcock at the house, but in some cases the hose emerges from the lawn at a point where an underground system of pipes comes to the surface. However, a citizen is not at liberty to water his lawn at any time he chooses. In 1900 the city was divided into four districts, each of which had its specific hours and special days of the week for watering. Today the laws are still strict, and it is so important to irrigate as much as possible during the allotted time that sprinklers are not turned off even during shower. The picture (Figure 20) was taken immediately after a 15-minute downpour when nearly a half inch of rain fell.

FIGURE 11.—Edge of Laramie, showing abruptness of transition from grassland to shaded, irrigated lawns.

FIGURE 12.—Laramie River in a wet year. Channel is characteristically irregular and shifting. In some dry years practically all water of the river is used for irrigation and the channel is nearly dry.

Regulations for the use of water in Laramie in 1938 are officially as follows:

Use of Water

Sec. 1. It shall be unlawful for any person, persons, company or corporation to draw water from any water pipe or hydrant within the limits of the City of Laramie, or to use the same for irrigating lawns, flower gardens, shrubbery or trees, or to let water flow therefrom except for culinary, household or manu-

facturing purposes only, at any time, or in any way, except as provided by the terms of these regulations.

Shall Prevent Waste

Sec. 2. It shall be unlawful for any person, firm or corporation using water from the water system of the City of Laramie to allow water taps, faucets or hydrants to remain open so as to permit the water to run therefrom in a wasteful manner, or to prevent the freezing of pipes, or for the purpose of cooling milk or other substances. It shall be unlawful to use water for irrigation so that water escapes outside curb lines or flows in street gutters.

Hours

Sec. 3. It shall be unlawful for any person, persons, firm or corporation to use or permit the use of water from the City water system for the purposes of irrigation, except as follows:

Users of water situated on the east half of any block where the alleys run north and south, and on the south half of any block where the alleys run east and west, may use water for irrigation during the periods from 6 to 8 a.m. and from 6 to 8 p.m. on Mondays, Wednesdays and Fridays of every week, and on Sundays no irrigation is permitted.

Users of water situated on the west half of any block where the alleys run north and south, and on the north half of any block where the alleys run east and west, may use water for irrigation during the periods from 6 to 8 a.m. and from 6 to 8 p.m. on Tuesdays, Thursdays and Saturdays of every week, and on Sundays no irrigation is permitted.

Exceptions

Sec. 4. The regulations of the preceding section shall not apply to the following users of water who are hereby limited to the period of 1 p.m. to 5 p.m. on Mondays. Wednesdays and Fridays of each week; all properties of Albany County, School District No. 1, all churches, on properties owned and operated by them, and all public or semi-public properties.

FIGURE 13.—Swimming pool near Laramie River.

Sec. 5. New lawns and new shrubbery may be irrigated daily in reasonable amounts, but only during hours specified for each particular class of users set forth above.

Use of Hose

Sec. 6. It shall be unlawful for any person to use a hose without a nozzle and the outflow through the pipe, nozzle or other aperture shall not be greater than one-quarter inch in diameter; and

FIGURE 14.—Main irrigation ditch at a ranch near Laramie. From a distance it can be detected by a narrow strip of green through brown range land, and by the thin line of trees watered by it.

it is hereby declared to be unlawful to use hose or pipe that has been cut, broken, worn or injured so as to permit water to leak through the same.

Use on Private Paved Area-Ways

Sec. 7. The use of water on paved areas whether inside or outside of buildings for the purpose of washing or cleaning the areas is hereby prohibited, except by special permission of the City Engineer.

Notice

Sec. 8. These regulations will be strictly enforced in their entirety, and this publication constitutes a due and legal notice to all users in the City of Laramie who are taking water from the City water system.

ELMER K. NELSON,
City Engineer.

FIGURE 15.—Irrigated alfalfa field near Laramie.

The city of Laramie from the year of its founding has made use of water from natural artesian springs not far from the base of the Laramie Mountains. Interbedded sandstone and limestone of the Casper Formation outcrop in the mountains themselves, and dip sharply westward toward Laramie, which is situated on a plain of truncated overlying sediments. Wells within the city tap water-bearing sands of the Casper, and several important springs emerge through natural fissures. The Artesian basin is comparatively small, and the collecting basin within a few miles of the springs, so that the effect of the drought of the early 1930's was markedly felt in decreased flow of water. The City Springs, only a mile from the east edge of the city in the very early days flowed into a ditch which carried water to the city in the first years of settlement. Since 1874, however, the water has been conducted through a pipe line, and in recent years it flowed in much smaller volume.

FIGURE 16.—One of Laramie's broad streets lined with shade trees. The cottonwood is the most numerous tree, of which Laramie has many beautiful examples.

The supply is sufficiently high above the city to maintain pressure in the city mains by gravity, and pumping is not ordinarily necessary. However, in the last year or two the natural flowage from the springs has been insufficient for the needs of the city, partly because of the city's growth of population and partly because of diminished flow resulting from long-continued withdrawal of water from the natural storage basin. Twenty years ago the population of approximately 5,000 people used 2,600,000 gallons a day, while today nearly 11,000 people use approximately 4,750,000 gallons a day. At one time the natural flowage from the springs was

FIGURE 18.—Hollow tile furnishes water channel to roots of tree; a common method of irrigating trees in Laramie.

FIGURE 17.—Liberal Arts Building, University of Wyoming, one of the beautiful new buildings on the campus. The grounds have been well landscaped and liberally planted to trees and shrubs. The campus has a number of beautiful new buildings.

sufficient to meet this need, but at present the flowage is only 3,500,000 gallons a day and the remainder must be pumped. This probably represents a lowering of the water table several feet. A small portion of the supply is drawn from Pope Springs (Figure 21) and Soldier Springs. All three springs are of the natural artesian variety, where a deep opening allows water to escape from tilted layers of sandstone where it has accumulated under pressure. If the population of Laramie continues to increase, with proportionate greater need of water, and probably also if the supply is to be kept even at its present level, the problem of an additional supply must be met, for the present quantity used is greater than that being naturally added to the Artesian basin. The cost of tapping a new source would

FIGURE 19.—Earth mound around base of tree. The small reservoir so formed makes irrigation easier. This method is usually used only for small trees.

FIGURE 20.—Irrigating a lawn with sprinklers. Hours for such irrigation are definitely limited by city ordinance. See text.

be considerably heightened by the necessity for purification, if surface water were to be used. The present supply, issuing from bed rock into carefully protected reservoirs, needs no treatment. Thus the city faces a real problem in expense as well as in actual quantity of water.

The people of Laramie today pay no specific bills for use of water. There are neither meters nor flat rates. Many people feel that in an arid region water should be used abundantly to beautify the city, as well as for domestic purposes, and free water, subject to the restrictions quoted from the municipal ordinances, encourages use. But if increasing needs are to be met, the possibility of curbing waste by introducing a meter system is worth considering, and some persons have suggested it for Laramie. Drilling wells would not augment the supply, since wells would tap the same water-bearing sands from which the springs flow, and the water content of those sands is already diminished.

An important possible source of future supply is the Medicine Bow Mountains, 35 miles west of the city. Because of their height above the surrounding country, they receive much more rain and snow than the Laramie Plain. The little town of Centennial, at the base of the mountains, receives more than 50 per cent more rain than does Laramie,

FIGURE 21.—City springs, on outskirts of Laramie. Reservoirs carefully protected by widely spaced double fence. Laramie Mountains in background.

FIGURE 22.—Lake Marie, in the Medicine Bow Mountains. Snow lies on slopes all summer. Crest range of pure white quartzite. The range is locally and affectionately called "Snowy Range." Its water may some day supply Laramie. Today it is valuable as a scenic attraction.

and not infrequently the annual rainfall is twice as great. Higher on the mountain the quantity is much greater. The Medicine Bow National Forest which covers the slopes not only gives evidence of the greater precipitation but also forms a permanent regulatory influence upon the flow of streams emerging from the mountains. Furthermore, there are numerous lakes (Figure 22) in the higher sections, and snow lies in some of the sheltered spots during the entire year. On tributaries of the Laramie River and others, National Forest Service measurements show that snow as late as by March 31 has accumulated to a depth of 50 to 100 inches. The water supply is therefore plentiful, and not likely to dry up in summer. River diversion and a long pipe line, with the purification plant which would be necessary, make the project of adding this source to the present supply expensive, but it is always a possibility and allays any fears which Laramie may have of water shortage.

The rock source of Laramie's present supply of water is used by others beside the municipality. The University of Wyoming has its own wells, and in 1938 has constructed a new irrigation system

FIGURE 23.—Irrigation ditches on the campus of the University of Wyoming. Sand bags divert water from one channel to the other.

FIGURE 24.—Irrigation by flooding, University of Wyoming campus. Sandbags provide the dam and tiny trenches through the lawn direct the flow toward trees if desired.

for its campus. Nearly all the walks across its broad lawns are paralleled by concrete ditches, and somewhere on the campus water is flowing through them every day. Figure 23 shows the method of diverting water from one ditch into a branch concrete canal, by means of a sand bag barrier. Where actual irrigation is desired, it is accomplished by flooding, as shown in Figure 24. Here sand bags are piled along and across the small ditch, forcing water out over the lawns. Small trenches 4 inches across and 2 inches deep are cut at intervals through the turf, to conduct water to gardens or groups of trees. Though much of the campus is built in shallow grassy basins which facilitate the spread of water, in some sections sprinkling is still necessary.

Water is abundant in Laramie, scarce on the surrounding plain. Geologic structure has been favorable for a relatively large supply, adequate, if not ample, for all the needs of the people up to the present time. The supply has been easily and cheaply obtained since purification is unnecessary and the slope from spring to town makes it a gravity supply. But today Laramie is looking to the future, for her water problem may become critical. A large quantity in proportion to the population is required if the beauty of the community is to be maintained. Whether the first step is conservation through a meter system, or an addition of more water from distant mountains, she need not fear a water famine. Fortunate indeed in this respect is this city of the plains.

Note: The writer wishes to thank Miss Ruth Linder, Geographer at the University of Wyoming, for much of the information contained in this paper, and for the opportunity to see and learn about the region, for without her assistance it would have been impossible. Mr. E. K. Nelson, City Engineer, also kindly contributed statistical and other information concerning city water supply. F. E. Hepner's "Forty Years of Weather Records," Bulletin 209 of the University of Wyoming Agricultural Experiment Station forms the source of the meteorological data.

CHEESE REGION OF SOUTHEASTERN WISCONSIN

Loyal Durand Jr.

THE Southeastern Cheese Region, located in part of the drumlin district of southeastern Wisconsin, is one of the outstanding dairy sections of the United States. Dodge County, the core political unit of the region, is the leading cheese-producing county of Wisconsin, accounting for over ten per cent of the state's output. The region produces over 14 per cent of Wisconsin cheese and the state, in turn, contributes more than half of the nation's cheese. The Dodge region covers an area of approximately 1,500 square miles, and extends from its Dodge County center into several surrounding political units.

Type Landscape

Many visible elements of the landscape attest to the importance of dairying in general and cheese manufacture in particular. Large dairy barns, 85 per cent of which are painted red, are the most characteristic landscape features of the region. As outstanding as the barns are the silos, many of white concrete, and the region as a whole has an average of more than one silo per farm. Milk houses, cattle yards, night pastures, and substantial acreages of marsh pasture, woodland pasture, and upland permanent and rotation pasture are all obvious signs of the outstanding rural industry of the region. In addition, large herds of cattle, averaging more than 100 in number per square mile, are evident in the region during the warmer portions of the year, and may be seen in the snow-covered barnyard on clear winter days, huddled in the shelter of the straw stack remaining from the oats and barley threshing of the preceding summer. At rural crossroads sites are located the 220 cheese factories of the region. These long low structures are preferably built into the side of a hill, where the lower, below ground portion can serve for cheese-making and cheese-storage rooms, while the upper story can be utilized as living quarters for the cheese-maker and his family. Other landscape features reflecting the interest

FIGURE 1.—The Southeastern Cheese Region of Wisconsin is northwest of Milwaukee and northeast of Madison. Dodge County is the leading cheese-producing county of the state.

of the Dodge region are found in the villages and small cities, where large dairy plants—some of them condenseries, and some of them corporation-owned cheese factories—are located. Warehouses, cheesebox-fabricating plants, milk collecting stations, and small manufacturing establishments occupy desirable switchyard sites. Landscape elements of daily recurrence within the Southeastern Cheese Region likewise emphasize the local interests. Trucks filled

FIGURE 2.—Cheese factories operating in Wisconsin in 1938. Compare with Figure 1 for location of the Dodge region. The inset shows creameries that made some cheese, but are not usually engaged in the latter occupation.

with milk cans cover daily routes from farm to farm or cheese factory to cheese factory, and tank trucks convey larger quantities of milk to condenseries or to the markets of Great Lakes cities. The generally rectangular network of gravel and concrete highways also serves as routeways for the farm auto, truck, wagon, or sleigh on its daily short journey from farmstead to cheese factory. The life of the rural portions of the region pulsates in response to the rigid 365-day year requirements of intensive dairying, while the rhythm of life in the urban centers likewise reflects a strong imprint of the regional interest, since many of the local factory operations are based either upon the use of milk as a raw material or upon the surrounding dairy farmers as consumers of products used in milk production.

SETTING OF THE REGION

The Southeastern Cheese Region occupies part of the drumlin country in the humid continental short summer Dfb climate of glaciated southeastern Wisconsin. A generally thick drift cover, the top of which is etched by hundreds of individual drumlins, mantles the underlying limestone bedrock. Only toward the eastern and western portions of the region do two escarpments project through the drift. The rolling lower magnesian escarpment on the west produces a series of undulating uplands with a locally rock-controlled surface, while the Niagara escarpment to the east rises as a narrow pastured and wooded rocky ridge throughout much of its extent across the region, attains an idealized cuesta form for a few miles, and eventually disappears under the glacial mantle.

The drumlins of the Southeastern Cheese Region range from clusters of long, low elliptical hills fifty feet high and a mile or more in length, to short stubby to rounded oval hills one hundred feet in elevation and barely half a mile long. They are commonly oriented in

FIGURE 3.—An excellent farmstead in the Southeastern Cheese Region of Wisconsin. This is located between Beaver Dam and Horicon, in the heart of the region. The silo has been filled, and surplus corn is shocked in the field for future shredding.

FIGURE 4.—A representative farmstead of the Southeastern Cheese Region. Enlargement of the barn has been made possible by the building of a second structure at the rear of the first. Note the glacial boulders in the foreground.

a north-south direction within the region, their alignment thus being in harmony with the arbitrary man-made rectangular land system. However, certain parts of the drumlin area have hills of a marked northeast-southwest trend. Where such is the case non-harmonic conditions commonly prevail, and field and road patterns depart from the rectangular land survey pattern by angles ranging as high as 45 degrees.

Long narrow fields devoted to hay, corn, oats, and barley on the 120-acre average farm of the region reflect the outstanding drumlin topography. Cultivation parallels the long axis of the individual hills, the fields occupying the sides and crests, and even the swales between two drumlins, providing in the latter case that drainage is naturally satisfactory or has been furnished by man. Farm woodlots crown individual drumlins, commonly occupying the steep slope of the stoess end, but occasionally on the steep side slopes. The woodlots are of mixed hardwoods, with maple and basswood predominating in the eastern part of the region and oak and hickory in the western portion. The distant vista is thus one wherein woodland crowns depict individual drumlins, but where not all drumlins are wooded. The second outstanding feature of the distant skyline is the farmstead on a drumlin. Houses, barns, and silos of the farms located along a drumlin-crest highway are more striking to the scene than are the farmsteads located on the slopes or in the drumlin swales.

The Southeastern Cheese Region lies on the outer fringe of the market milk section of southeastern Wisconsin. Distances of forty to sixty miles separate the area from Milwaukee, and the great intensity of dairying close to that city makes it unnecessary for milk distributors to tap the Dodge area; Chicago, 150 miles away, reaches for milk just to its border. The southern margin of the region is thus one of intensive competition among cheese factory, condensery, and Chicago distributor. The heart of the area, however, is over the competitive border, and the cheese industry of the region has been able to maintain

FIGURE 5.—The Duenow farmstead. (See farm pattern map, Figure 15, for location.)

itself in part because of the geographical position.

Factors of unity in the landscape of the Southeastern Cheese Region are associated with its outstanding regional specialization. Since a region is in many respects an areal convenience selected for a purpose, it is evident that its characteristic landscape, about which it is defined, is at its core. The characteristic landscape spreads outward with decreasing intensity until at the borders of the region the landscape merges with others through a zonal belt, which may upon occasion be sharp and definable in terms of a single natural or cultural element. More commonly the regional border is a compromise between various changing elements; hence the viewpoint of the investigator determines upon a compromise border. The Dodge Cheese Region border is marked visibly by the outer edge of cheese manufacture, the dropping of the crossroads cheese factory from the cultural scene. In detail the change in the landscape association is also marked by changes in characteristic farm type and land-use, but these changes are mantled under the general cloak of a continuing dairy industry. Since cheese manufacture carries with it a characteristic set of cultural forms, the outer border is largely one wherein competing uses for milk force the cheese factory from the cultural scene. Thus the regional border is marked (1) by a thinning out and eventual disappearance of the cheese factory; (2) by the movement of milk in many and diverse ways and directions; and (3) by a competitive

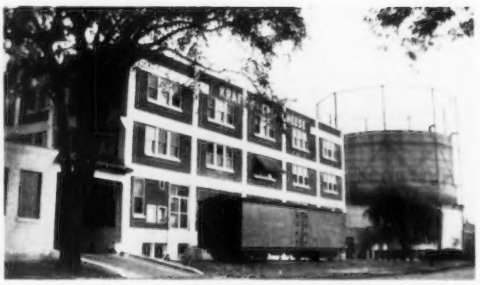


FIGURE 8.—The Kraft-Phenix cheese factory at Beaver Dam, Wisconsin.

FIGURE 6.—The long upper portion of the cheese factory is used as a residence. The milk-receiving and cheese-making rooms are in the excavated lower portion of the building. Note the barn and twin silos of the drumlin-crest farm in the right background.

FIGURE 7.—Milk delivery at a Dodge County cheese factory. Muenster cheese is the product of the plant.

FIGURE 9.—A Dodge County gravel highway on a drumlin crest. The daily travel of the farmer to the neighboring cheese factory is over this type of road. The roads are in good repair at all seasons, but are temporarily blocked by drifting snows in winter.

zone wherein no single milk-use nor milk plant dominates the local scene.

THE DODGE CHEESE INDUSTRY

The Southeastern Wisconsin Cheese Region in 1937 produced somewhat more than 48 million pounds of cheese (Wisconsin 324 million), nearly 15 per cent of the state production. Brick and Muenster cheese, the product for which the region is particularly noted, accounted for 20 million pounds, 56 per cent of the state's production, and these two similar varieties formed nearly half of the total output of the Dodge Region. Other varieties of cheese fabricated in the area included nearly ten million pounds of cream, nine million pounds of American, half a million of limburger, and a substantial output of both French and Italian varieties. The outstanding production factors in the Dodge Region in recent years have been: (1) a declining percentage of brick cheese manufacture coupled with (2) an increase in the total cheese output. This has resulted in an increasing percentage and output of varieties of cheese other than brick, the most marked shift having been to American, cream, and the Italian varieties of cheese.

Economic and human factors largely have been responsible for the trend toward varieties other than brick. Recent years have seen relatively low prices for brick cheese; huge surpluses of cheese, particularly brick and American, have been stored in warehouses, where they now lie at the root of political agitation for national governmental spending to stabilize the cheese market. Tariff walls protect some of the foreign cheese manufacturers of Wisconsin, notably the Swiss. With certain market factors thus upset, the Italian varieties have recently paid a premium. Italian cheese has been imported into the United States in increasing quantities. Prices have held. Economic forces and factors operating broadly set the stage; the presence of an Italian cheese factory at one location in the Southeastern Cheese Region served as a stimulus. Many factories in the vicinity shifted to pro-

FIGURE 10.—View of landscape of the drumlin country in the Southeastern Cheese Region of Wisconsin. Woodlots crown many of the drumlin crests. (Courtesy of Prof. W. Credner.)

duction of Provolone, Provoletti, Asigo, and other Italian varieties. The landscape of the portions of the Dodge Cheese Region so shifting was somewhat modified; low brick and concrete smoke houses have been erected in the sidehills adjacent to the crossroads factory in order to care for necessary smoking of the cheese. Thus within the region itself visible landscape elements help to distinguish certain types of product fabricated in the area.

The chief working unit of the cheese industry, no matter what the product, is the crossroads factory. These frame structures, whose characteristic site and situation has been indicated, are most numerous in the southeastern portion of the Dodge Region, where they are on the average but two and a half miles removed from one another, and where several individual square miles contain two cheese factories, and one has three. Their spread increases to four and five miles toward the western and northwestern portions of the region, and thence gradually widens into the competitive areas toward the outer regional border.

The cheese industry is built upon the product of the 220 factories. Each of these units, with its small surrounding territory from which it draws its raw material, is the atom within the region. The combination of these 220 units in their larger association gives the Southeastern Cheese Region its distinguishing landscape character. Not only do these

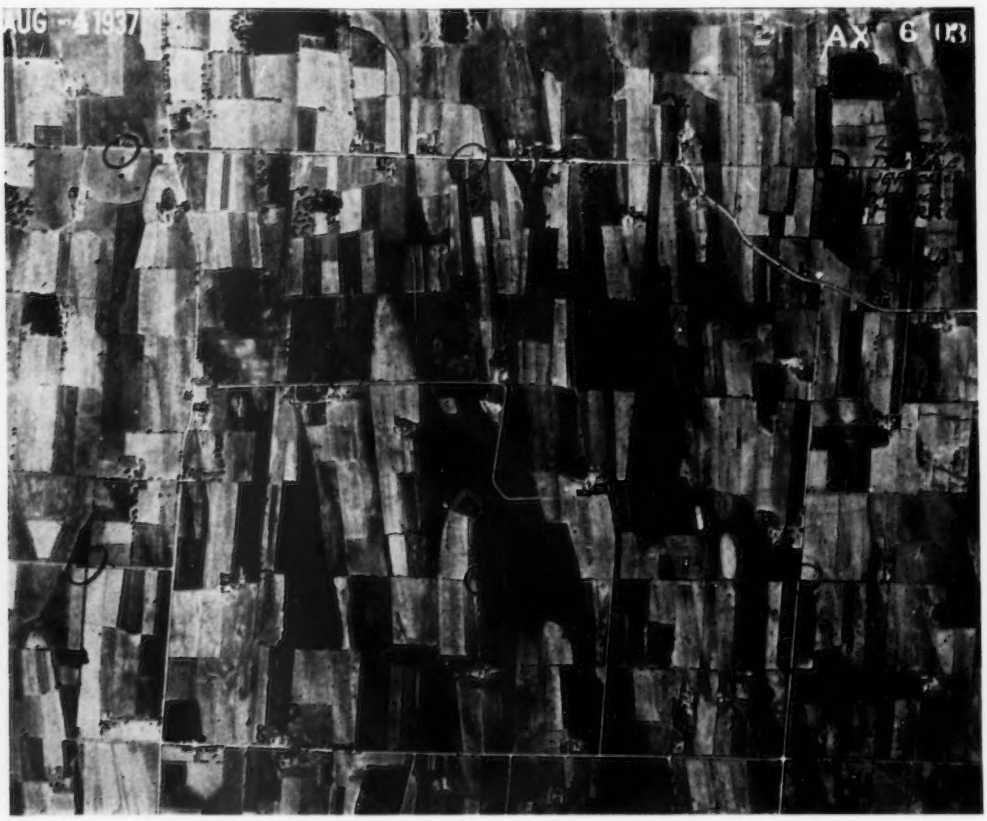


FIGURE 11.—Drumlins aligned in a north-south direction, in harmony with the man-made rectangular pattern. Notice the field and road relationships to individual drumlins. The north-south road in the western portion of the area bends around the base of a drumlin.

FIGURE 12.—Side view of a detail of the drumlin landscape. The fence in the center divides two farms. On one farm the fields are long and narrow and parallel the long axis of the drumlins. This is usual in the sections of large drumlins. (Courtesy of Prof. W. Credner.)

individual units compete with each other for territory and milk, but they compete with the condensery and large urban cheese factory. The result of this is the complex flowage of milk along the region's routeways.

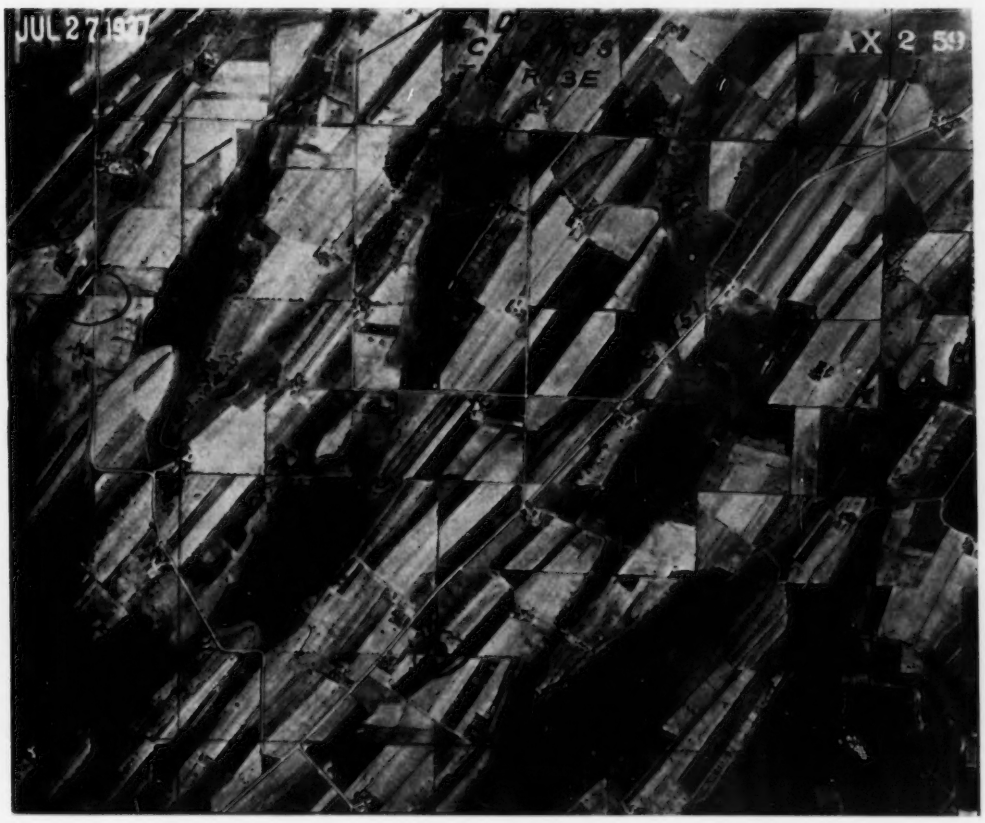


FIGURE 13.—Drumlins aligned in a northeast-southwest direction, producing non-harmonic relationships. Man's north-south and east-west survey pattern has been stamped on this area, as can be seen by examination of the farm boundaries. Within the farms the longer axis of the fields is parallel to the drumlin alignment. The major highway (U. S. 151) follows crests and swales of the drumlin terrain.

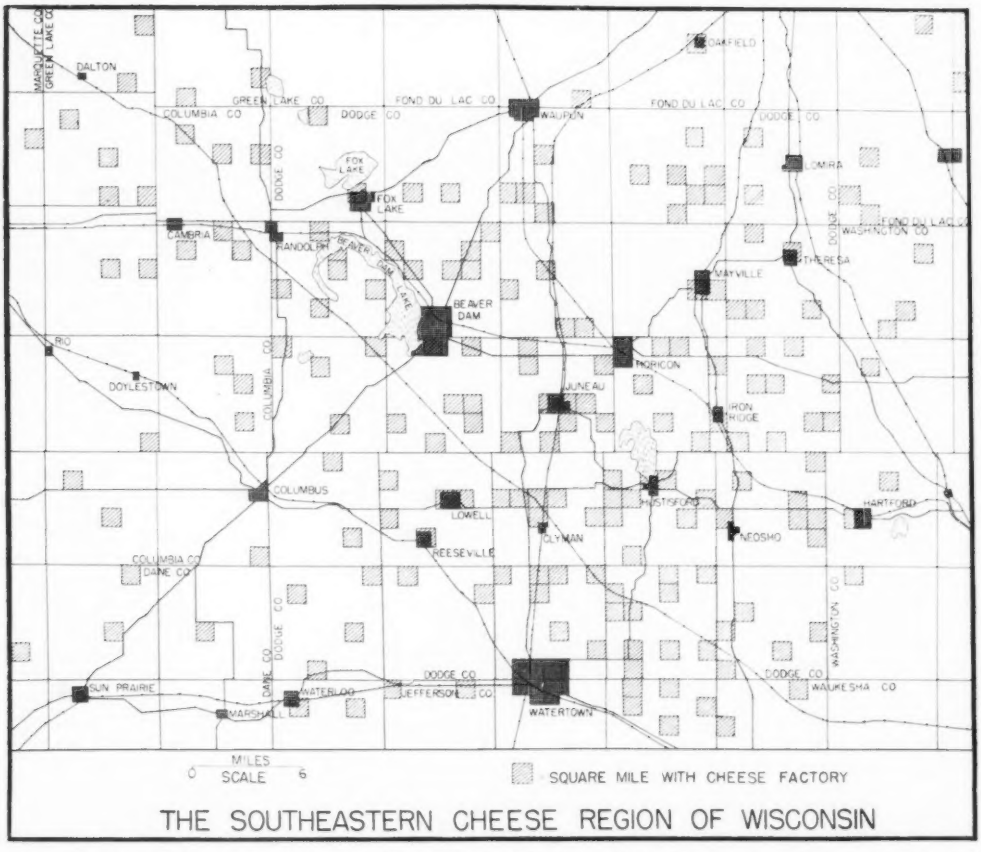


FIGURE 14.—Cheese manufacture within the Southeastern Cheese Region is widespread, although there is somewhat of a concentration of cheese factories in the southeastern part of the area. Each of the shaded areas on the map is a square mile (section) with a cheese factory. Some of the sections have more than one cheese factory located in them.

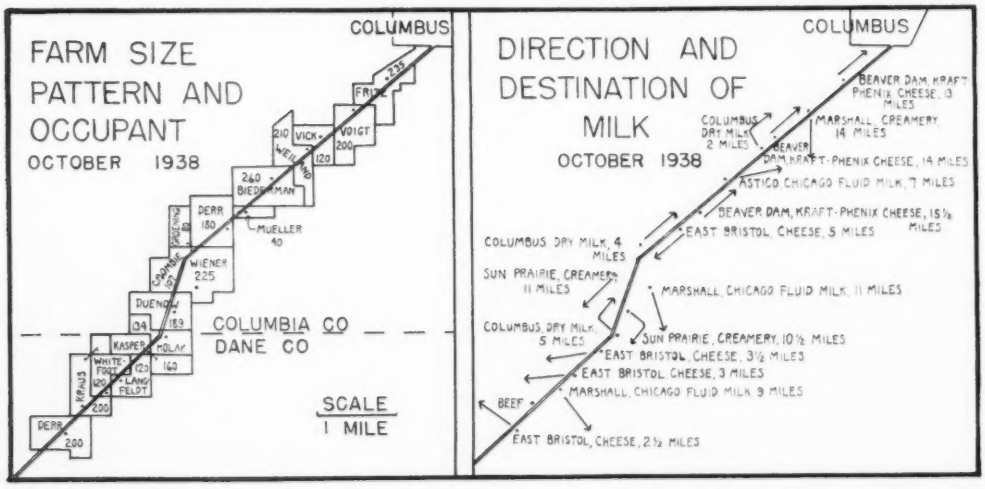

FARM SIZE PATTERN AND OCCUPANT
OCTOBER 1938
COLUMBUS
COLUMBIA CO
DANE CO
SCALE
1 MILE
DIRECTION AND DESTINATION OF MILK
OCTOBER 1938
COLUMBUS DRY MILK, 2 MILES
BEAVER DAM KRAFT PHENIX CHEESE, 13 MILES
MARSHALL CREAMERY, 14 MILES
BEAVER DAM, KRAFT-PHENIX CHEESE, 14 MILES
ASTICO CHICAGO FLUID MILK, 7 MILES
BEAVER DAM, KRAFT-PHENIX CHEESE, 15⅛ MILES
EAST BRISTOL CHEESE, 5 MILES
COLUMBUS DRY MILK, 4 MILES
SUN PRAIRIE, CREAMERY, 11 MILES
MARSHALL, CHICAGO FLUID MILK, 11 MILES
COLUMBUS DRY MILK, 5 MILES
SUN PRAIRIE, CREAMERY, 10½ MILES
EAST BRISTOL, CHEESE, 3½ MILES
EAST BRISTOL, CHEESE, 3 MILES
MARSHALL, CHICAGO FLUID MILK, 9 MILES
BEEF
EAST BRISTOL, CHEESE, 2½ MILES

FIGURE 15.—The farms along the competitive border of the Southeastern Cheese Region send milk in many directions. Only in part does the milk move to cheese factories, and a portion of the border is reached by the northern edge of the Chicago fluid milk market. Note the size of the farms. The typical farm operator of the region is a native-born white of German descent.

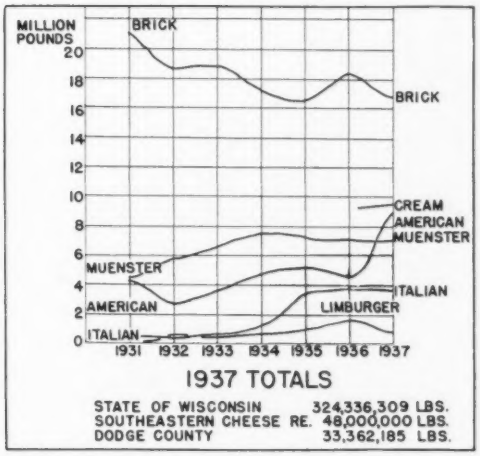


FIGURE 16.—Cheese production of the Southeastern Cheese Region of Wisconsin. Recent years have seen an increase of Italian, American, and cream cheese output. Brick and Muenster cheese, for which the region has been nationally famous, have declined relatively in output.

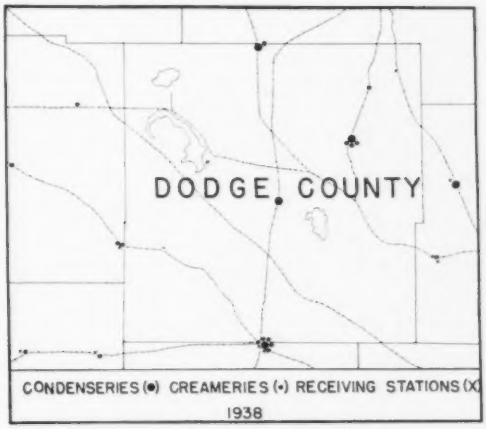


FIGURE 18.—Notice the relationship of the plant location to the railroad lines. Unlike the cheese factories the creameries and condenseries are located in the cities and villages, and at railroad sidings. The receiving stations shown on this map are the large ones; they receive milk for city markets, for condenseries, or for the Kraft plant at Beaver Dam.

A representative cheese factory of the region is the Rock River factory, one receiving a million to a million and a half pounds of milk as raw material each year; with this quantity it falls in the modal group both of factories of the region and the state. Eighteen farmers, all of whom reside within two and a half miles of the Rock River factory, deliver 7,000 pounds of milk a day in June, the flush month, and under 2,000 pounds a day in the low production month of January. The building housing the enterprise is owned by the surrounding farmers, but rented by them to a cheese operator and warehouse owner in a nearby village. This individual, who owns some factories but rents others, as he does the Rock River factory, sees to the collecting, warehousing, and sale of the cheese. He hires the cheesemaker, who is paid by the pound of cheese produced, and he determines the variety of cheese to be manufactured within the skill and capability of his cheesemaker. Thus the region's outstanding industry is handled, and is pyramided upon a

FIGURE 17.—The Rock River cheese factory. The building is built into the side of a drumlin. Another drumlin appears in the distance. The scene is in November; fall-plowed field in the foreground.

FIGURE 19.—Interior view of the Rock River cheese factory. This is the storage room, dug out of the drumlin side. The day's make of Colby-style American cheese is on the table. It is put up in "longhorn" style cheeses. In the background are basswood cheese boxes, each of which will hold four cheeses. (Courtesy of Prof. W. Credner.)

FIGURE 20.—A former cheese factory, now remodelled into a night club. Many factories located on the concrete roads of the region have been closed, for the milk can easily be trucked to the larger plants of the village and small cities.

broad base of small individualistic enterprises.

The small factory has been gradually disappearing, although it is still well entrenched regionally. The decrease in total number over a period of years has been the result of (1) bettered transportation, both from the standpoint of hard roads and of the maintenance of winter transportation, and (2) competition with the large corporation-owned cheese factory and condensery, able to pay more for raw material and transport it longer distances to their generally more efficient manufacturing units. Thus new urban units of fabrication have appeared and several of the crossroads units have been removed from the landscape, or modified to meet changing regional conditions.

OUTLOOK FOR THE REGION

The cheese industry is well established in the Dodge area. Cheese production has increased during the past ten years, intensifying the relative regional importance of the area to the industry in Wisconsin. This has been accomplished with fewer manufacturing units and a shift both to larger factories and to greater variety of types of cheese, a trend that will doubtless continue in light of present economic conditions.

LAND UTILIZATION OF THE UNIVERSITY LAKE DRAINAGE BASIN

F. C. Erickson and W. H. Levitt

UNIVERSITY Lake, an artificial lake formed by the damming of Morgan Creek, is located two miles southwest of Chapel Hill, the seat of the University of North Carolina. The lake, formed six years ago, has been filling at a rather normal rate for the section of the country in which it lies.

Henry M. Eakin has determined that during the first three years of the lake's existence, silting has taken place at the rate of 21.92 acre-feet annually. (Henry M. Eakin, *Silting of Reservoirs*, Technical Bulletin No. 524.)

University Lake was impounded for the purpose of supplying water to Carrboro, Chapel Hill, and the University of North Carolina. With an original storage capacity of 624,098,500 gallons, a figure far in excess of the present needs of only 45 million gallons, it is estimated that at the continued rate of filling it will take 78 years before the water supply for the towns will be seriously threatened. Nevertheless, a study of the drainage basin of the lake, comprising 27 square miles, reveals the causes for the silting which is taking place in this reservoir and many others in this locality, and in addition serves as a type study for land utilization and the problems confronting the farmers in the Piedmont region.

Agriculture has been the leading occupation of the people since the first settlement of the land, and very little change has taken place during the course of many years of land use.

Large areas of forested land were cleared and placed in cultivation with very little attention devoted to the maintenance of soil fertility and the prevention of soil erosion. Land was plentiful and when the fields were "worn out" they were abandoned and new fields placed under cultivation.

Today, the farms, with few exceptions, are infertile, the land mined of its fertility, the soil washed to the bottom lands, gullies traversing fields, and farm buildings dilapidated. It is only with grim struggle that most of the

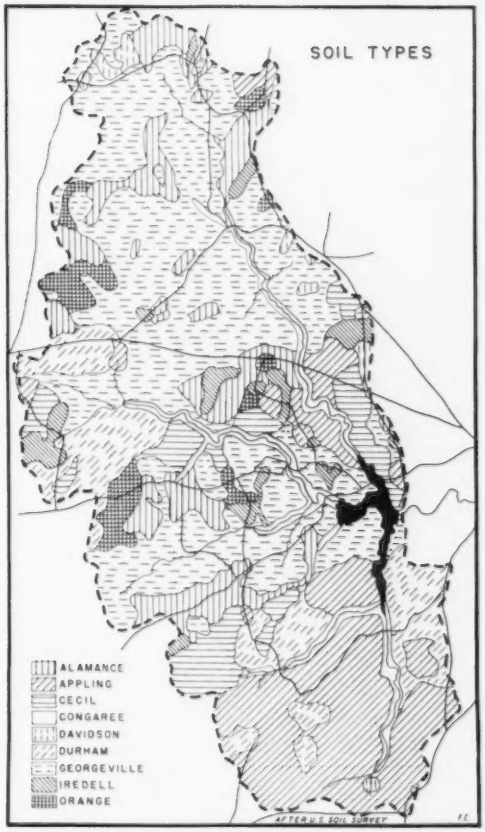


FIGURE 1.—Two main series of soils dominate the area—Georgeville in the north and Appling in the south—but the soil pattern is nearly everywhere complex because of many minor diversities in terrain.

people farming the area derive a bare subsistence from their impoverished acres.

TOPOGRAPHY

The University Lake drainage area is a rolling upland ranging from 400 to 500 feet above sea level with occasional residual hills within the basin, and along the outer border, rising several hundred feet higher.

The northern 80 per cent of this basin is drained by Neville and Morgan creeks, while the southern section is drained by Price and Mill creeks. It is only along these creeks and on some of the interstream divides that areas with A slopes (0–3%) are found. The greater part of the drainage area consists of hills with B slopes (3–7%), but occasionally C slopes (7–12%) and even D slopes (over 12%) are encountered.

No geological studies have been made of the region, but outcrops tend to show that the underlying rocks are complex crystallines, consisting of granite, gneiss, schist, diorite, gabbro, hornblende, silicon, shale, and other related rocks.

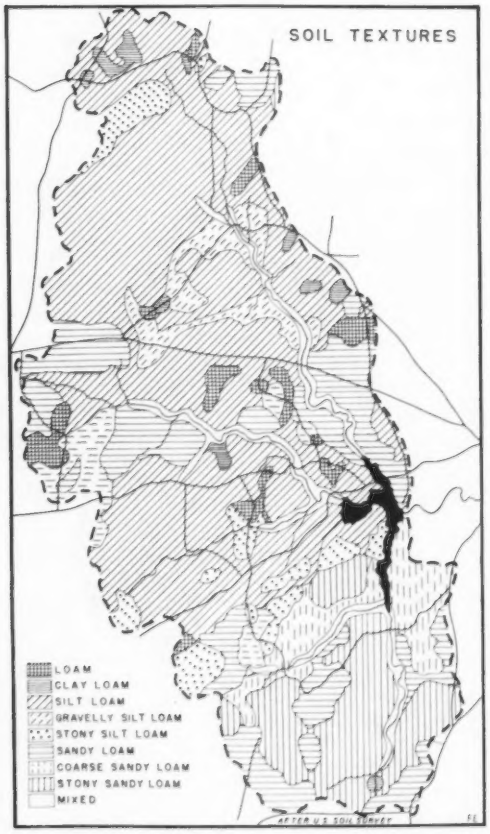


FIGURE 2.—The silt loam of the Georgeville prevails in the north and the sandy phases of the Appling in the south. Cotton and tobacco are found on the sandy phases, whereas the requirements of corn on soil texture and type are not so exacting, and corn is scattered over the entire area.

CLIMATE

Adverse climate is one of the chief causes for the poor conditions found here. The mean annual temperature for the past nine years is 61.6 degrees Fahrenheit, with an average of 52 days in which the temperature falls below 32 degrees. The average frost-free period for these years is 217 days. (From reports of the weather station at Chapel Hill, N. C.)

These figures tend to show that chemical weathering of rocks rather than physical weathering prevails. Furthermore, it shows that the ground is not frozen for any great length of time and that the agents of erosion can work on the land practically the entire year.

The mean annual rainfall for the period is 47.7 inches, well distributed throughout the year with a maximum during the months of July and August. The rainfall received in the area is of the heavy shower type. The average number of days with one or more inches of rainfall is 13. Although the figure is not high, yet 41 per cent of the annual rainfall falls during these days and usually in the growing season when the ground is constantly being cultivated. Under such climatic conditions, native vegetation consists of coniferous and deciduous trees.

SOILS

The soils belong to the Gray-Brown forest group and consist of the Georgeville, Alamance, Appling, and Durham series, with scattered areas of Iredell, Davidson, Cecil, and Orange series. The Georgeville soils derived from slates and fine-grained volcanic rocks cover most of the area.

In cultivated fields the topsoil has a dark red color when moist and light red when dry. In uneroded sections the topsoil has an average thickness of about seven inches. The subsoil, composed of compact clay, has a slight purplish or maroon shade with an average thickness of two feet and grading into a heavy, red silt loam for about a foot before it grades into the C horizon.

Georgeville soils are subject to ready erosion and both sheet and gully damage are rather extensive. In traveling around the drainage basin "galls" are evident on almost every cultivated field and they are easily distinguished by dark areas exposing the subsoil. Gullies two and three feet in depth are also numerous and conspicuous. Contour tillage is necessary and the use of only close-growing crops on slopes above 10 per cent is recommended.

Alamance soils also derived from crystalline rocks, chiefly slates, have just about the same depths in the different horizons. They are light in color, usually a grayish-yellow in the topsoil and brownish-yellow in the subsoil. They are slightly less erosive than the Georgeville, but again sheet erosion and gullying are common throughout.

The soils derived from slates are good for the growing of grains, clover, grass, and corn.

Appling and Durham soils are derived from light-colored rocks, especially granite, schist, gneiss, and related rocks.

The topsoils of the series are thicker than the Slate series by two to five inches. The Appling soils have a light grayish-yellow colored topsoil composed of sandy loam with a thickness of about 10 inches below which the subsoil changes to a yellowish-red friable clay to a depth of 2½ feet. In the lower part of the subsoil, the color changes to yellow and red mottled clay.

FIGURE 3.—A road cut into the Georgeville soil series reveals how sharp is the distinction between the "A" horizon and the "B" horizon. The Georgeville soils are subject to rapid erosion unless contour tillage is practiced.

The soils are subject to severe sheet and gully erosion and are more erosive than any other type found within the basin with the exception of the Cecil and Iredell series which are very limited in area. Appling soils are good for tobacco, truck, and general farming.

Durham soils have a light grayish-yellow sandy loam topsoil with an average thickness of 12 inches. The subsoil becomes a yellow friable clay gradually changing to a heavy sandy clay at a depth of three feet when the C horizon becomes gray and streaked with yellow rotten rock. Again, sheet erosion is quite active but these soils are less erosive than the Appling soils. The better types of the Durham soils, more than any other soils in the Piedmont, are suited to the production of tobacco.

The other soil series, Cecil, Iredell, Davidson, and Orange, are rather limited

in area. They are all subject to erosion and stand high in the list of erosive soils of North Carolina. They are not very fertile, but can be used with some success in the production of grains, corn, and clover with some types fairly suitable for cotton and tobacco.

The soils of the University Lake drainage basin in general can be classified as infertile. They have all been subject to severe erosion due to the

FIGURE 4.—Soil wash, so extensive that in a single season it obliterates deep furrows, constitutes one of the major problems in many of the soils of the South and results in heavy loss of productivity.

relief, climate, and type of agricultural practices. The topsoil is no longer intact except in rare places, but has been removed by sheet erosion and gullying. The amount of sheet erosion that has taken place can readily be observed everywhere in the basin. In many places the topsoil is completely removed, while in others there is from four to five inches of topsoil remaining. Considering the area as a whole, it is safe to say that the region has been subject to moderate to moderately severe sheet erosion with 25 to 75 per cent of the topsoil removed.

LAND UTILIZATION

Figure 1 presents the composite land utilization of this area at the present time. Since erosion is the biggest problem facing the farmer, the system of mapping employed is based on open and closed cropping.

Roughly speaking, 51 per cent of this area is in forests, 15 per cent in fallow land, 18 per cent in open crops, 9 per cent in closed crops, and 7 per cent in pasture. The percentage of open crops is much more impressive if we consider the open crops in relation to the total land in cultivation. From this point of view it may be seen that 67.6 per cent of the crop land is in open crops.

Much of the forest area includes scrub-pine forests on land that has been abandoned and has since grown up in natural vegetation as evidenced by the still obvious plow furrows in wooded tracts. Very little of the forest acreage is under proper management of thinning, cutting, and selection, while a somewhat larger part seems to be in the process of being completely stripped for use as firewood or pulp.

Of the land lying fallow, roughly half of it has been abandoned or is in possession of land banks and absentee owners. Some of the land still retains much of its topsoil and could be developed into good farm land if it were put to protective cover crops or woodlands, instead of lying open to rapid erosion and destruction.

PEOPLE

There are approximately 800 persons living in the University Lake area. Of these, 69 per cent are white and 31 per cent Negro.

The average farm tenure is 18 years and there are 4.9 persons per farm family. They live on farms averaging 103.3 acres, of which they cultivate 31.3 acres, six of these having been cleared since the farm was first occupied. There are 9.8 available acres of pasture land per farm.

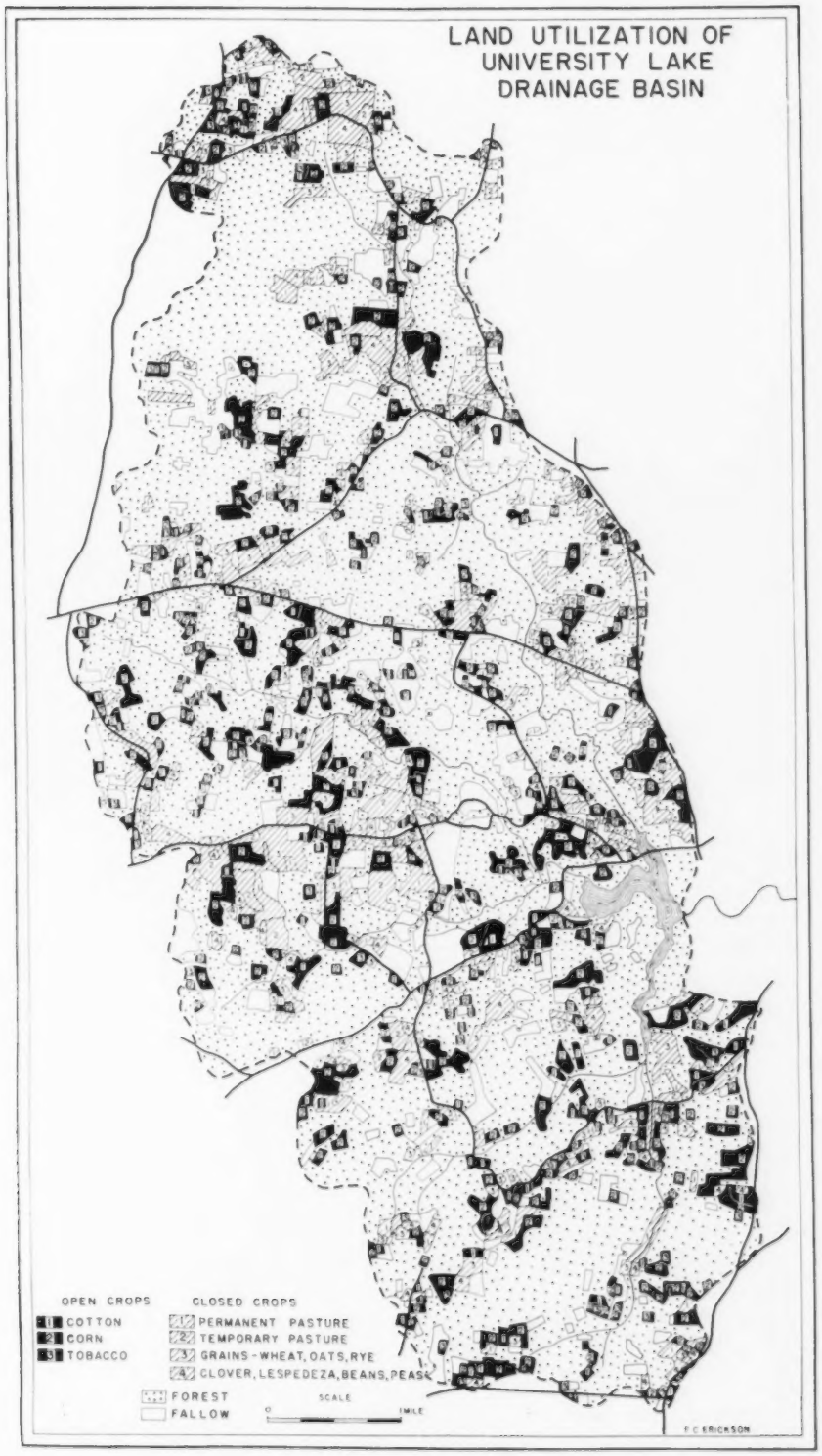


FIGURE 5.—The scattered pattern of land use and occupance, with pasture and cropland set as it were in a forest matrix is characteristic of a much larger section of the South than is represented in this study.

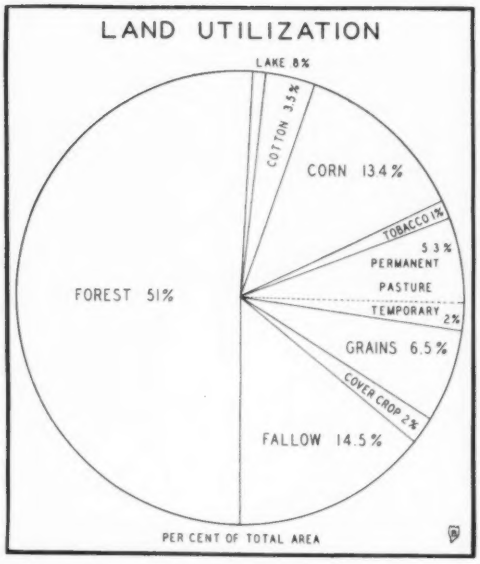


FIGURE 6.—The use of the land, expressed in this chart in percentages, is confined largely to forest, fallow, and corn, almost 80 per cent in the aggregate. Pastures occupy seven per cent, grains 6½ per cent, cotton 3½ per cent, and tobacco only one per cent.

64.4 per cent of the farms are owned while 35.6 per cent are cash rented or share cropped.

TABLE I

	Total	*White*	*Negro*
Owners	64.4	87.9	12.1
Tenants	35.6	34.4	65.6

The greater proportion of the tenanted farms is cultivated by Negroes while the large number of white owners accounts for the long average tenure. Of all the Negro farmers in this area 75 per cent are tenants, while only 19 per cent of the white farmers fall into this category.

Corn, the major crop grown in this area, comprises 50.7 per cent of the total crops grown, while grains equal 24.5 per cent, cotton 13.1 per cent, cover 7.5 per cent, tobacco 3.8 per cent and others .4 per cent. The shift here has been away from cotton, which was once the predominant crop of the area, and each year less of it is grown. Nevertheless, the 13.1 per cent is still too high a ratio and can be attributed mainly to the need of most of the tenant farmers for a cash crop. Practically all the larger self-owned farms have abandoned cotton completely. The farms which still raise cotton would cease to do so were there a substitute crop which could be grown intensively enough to provide the necessary cash. Tobacco seems to be the only alternative cash crop for the smaller farms, and while the University Lake basin has not been a particularly strong tobacco area, there seems to be some movement in this direction, especially since tobacco control has been defeated and tobacco prices in the last two years have been high.

While much of the soil of this area can be considered good tobacco soil, the true picture shows that tobacco culture would not be the proper land use for the future. This farm area is mature, one in which the crops have traditionally been of an open type, swinging gradually from cotton to corn. The soil fertility is exceedingly low, and a great part of the topsoil has been removed. While tobacco culture requires an excessive amount of fertilizer, the fertilizer use in this particular area is high. At present, the farms in this area are averaging 100 pounds of fertilizer an acre for all cultivated acres, and only 13 per cent of the farms reported that they had sufficient fertilizer for their needs. At best, this area would be a marginal producer of tobacco, just as it is a marginal producer of cotton, and it will require exceedingly high prices in the future to guarantee a successful crop, a condition which becomes more doubtful with the failure of government control of tobacco.

The great loss in soil fertility, due to the type of crops grown, is further in-

FIGURE 7.—Second-growth timber that has reestablished itself upon land once cultivated is being felled and new fields wrested from the cleared land, suggesting tropical "milpa" practice, in modified form.

tensified by the lack of adequate rotation practices. Only five per cent of the farms in this area are practicing proper rotation, while 41 per cent are practicing fair rotation. Twenty-five per cent practice a minimum rotation of crops (corn-wheat-corn), while nine per cent report that they follow the crop-fallow-crop plan, and 20 per cent have no rotation at all.

Naturally, with the large per cent of farms following little or no rotation, and with the great predominance of open crop farming, erosion in this area goes on at a rapid rate. There is much evidence of straight-line plowing on steep slopes which require following the contour, and occasionally evidence of vertical furrows on B and C slopes.

Soil erosion control practices, sufficient for the area's needs have not been adopted, despite the efforts of the government to check erosion through control measures and soil building practices, and the establishment of a farm terracing unit which the county provides for a fee of $3.00 per hour.

Although the area was under control for cotton and tobacco, there was no compulsion to adopt soil building practices. Seventeen per cent of the farms are not signed either for soil building or crop control; 43 per cent of the farms are receiving payments under control acts, while 16 per cent are engaged in soil building practices and 24 per cent are using both crop control and soil building measures. Nevertheless, in estimating actual soil erosion control practices of terracing, draining, ditching, and contour farming, 31 per cent of the farms reported no erosion control of any kind. Of those reporting erosion practices, only 11 per cent had made use of the county terracing unit, eight per cent had built terraces themselves with the advice of the county agent as to the layout of the fields, 59 per cent built their own terraces with no assistance, and 22 per cent were making use of the terraces and ditches already on the farm when they arrived. Of 71 farms reporting, only four had had the help of the CCC in laying out their fields, while four farms in this area had members in the CCC at some time. Three of these were practicing full control measures and the fourth was planning to do so.

The farms which had the CCC help, as well as the 11 per cent which hired the county terracing unit, were for the most part the larger and better equipped farms, either owned outright by the farmers or owned by professors at the near-by university. The farmers

FIGURE 8.—The low carrying capacity of southern woodland pastures, unmodified by fertilizer and other practices for conserving soil and improving fertility, is everywhere apparent throughout the region.

FIGURE 9.—Not much is needed, often not much is desired, in the way of habitation and material comfort by the share-cropper who tills the rented land. A share-cropper's cottage suggests low income, and in many cases weak ambition.

in greatest need of the service were in the majority of cases poor tenants who could not afford the rent of the unit or who were not aware of the factors underlying erosion and loss of soil fertility. It was on these farms that straight line plowing and no rotational practices were most heavily indexed. Here also was the greatest degree of erosion. In some cases tenants were found practicing a one crop system, who were perfectly aware of underlying causes of erosion, but who stated that the cash necessary for erosion control practices was needed for fertilizer and rent and that another farm could always be found when the present one "played out."

The destruction of the soil is reflected in the living conditions of the people of this area. While the farms in this section are above the average for the state in the number of livestock owned, actual farming conditions are declining.

TABLE II

LIVESTOCK PER FARM

Cattle	2.7[1]	Hogs	3.9
Horses	.4	Chickens	51.6[2]
Mules	1.1	Others	.01

[1]Excludes 9 dairy farms (Av. 19.4).
[2]Excludes 2 poultry farms (Av. 1000).

With a constant effort being made to build up the farm, only 46 per cent reported an increase in yield per acre over a long period of time; 37 per cent reported a decrease, and 17 per cent had the same yield.

Seventy-two per cent of the farms reported that they grew food sufficient for their needs, 22 per cent grew part of their food, and six per cent did not grow any food for home consumption.

Dividing the "Standard of Living," "Housing," and "Condition of Farm" into four categories: (1) Good; (2) Fair; (3) Poor; (4) Bad, on the basis of adequacy and need in the case of "Standard of Living" and of actual physical condition in regard to "Housing" and "Condition of Farm" the following per cents were derived:

FIGURE 10.—According to rule the better farmsteads and the better homes are on the better soils, owned by the better farmers.

TABLE III

	Standard of Living	*Housing*	*Condition of Farm*
Good	29	27	12
Fair	50	39	38
Poor	15	29	28
Bad	6	5	22

A factor which probably raises the general standard of living is the fact that two out of three farms on the average, have a member working part time in town, although living on the farm. In respect to housing, five per cent of the dwellings are unfit for human use, and 29 per cent are in need of major repairs—a total of 34 per cent of the houses that are far below sub-standard level. The general condition of farms in this area is poor to fair and would probably be worse except for the rather long period of tenure.

That there is a definite relationship between the rate of erosion and the standard of living there can be no doubt. Certainly, this is an area with a high degree of erosion, most of which is a result of the economic conditions under which the farms operate and the consequent misuse of the land. To bring about a solution of the problems and amelioration of the difficulties requires a consolidation of economic and social factors with the physical control and checking of the forces of nature. It is not enough to know how to control erosion, or what the proper land utilization is; it is just as necessary to know how to put the best practices into effect.

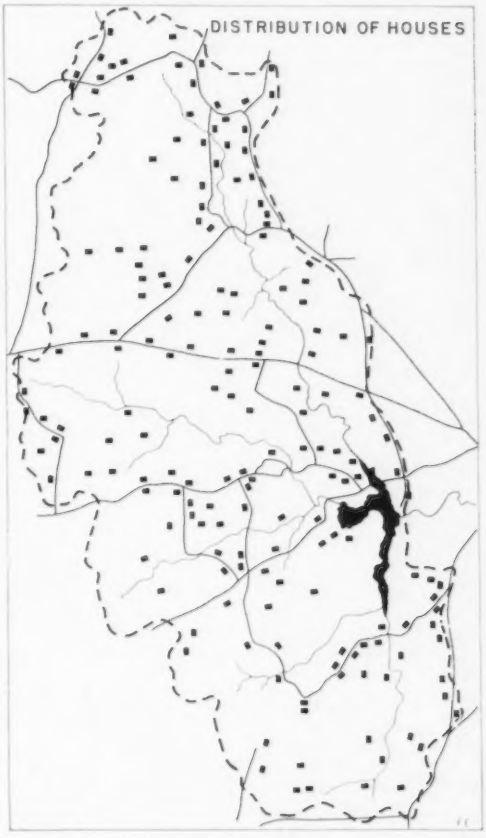


FIGURE 11.—Most of the houses are located on uplands and along roads. There is no regular pattern of houses except for these two factors. The houses are seen to be rather crowded for the restricted resources and advantages of the area. Many houses are old, and some are vacant.

SUMMARY

In this study it is plainly evident that there is a striking correlation between the physical and social factors, and that a thorough understanding of the area embodies a knowledge of both the land and the people. The land in this region is relatively poor. The soils are erosive in character, the region is hilly, and the climate is such that the precipitation, chiefly in the form of rain, is of the heavy shower type. These factors in themselves would make for an eroded area. As these physical factors predicate a poor land, no less do the human factors make their contribution.

The misuse of the land began with the early settlers who abandoned a field that did not give a satisfactory crop, for a newer piece of ground. At present, economic necessity forces the farmers to raise crops which leave the fields open

much of the year with no cover crops to aid in keeping the top soil from washing away. Consequently there is and has been a constant draining of land fit for agricultural purposes.

Some of the farmers of this region actually do not know what to do to keep their fields from losing all their value as farm areas. They are not acquainted with practices of soil erosion control and land utilization and they work on the theory that farming practices of the past are proper for the present and future. If the land washes away or the soil becomes infertile it is in the nature of a necessary evil—to be lamented but not to be resisted. These farmers could profit much from information about assistance available from government agencies, the CCC, their county farm agent, and education as to proven methods of land improvement and good land use.

Many of the farmers are tenants who have no great worry about the care and preservation of land which they do not own, and which they will soon leave.

Many of them, both tenant and owners, who are eager to improve the land are financially unable, because of the low prices for cotton and other crops, to institute soil erosion control, make repairs on the farm, buy sufficient fertilizer for their needs, or make any contribution to keeping the land in good shape. Thus poor land makes poor people and poor people make poor land in a vicious and ever widening circle. The problem must be solved, if it is to be solved, by a consideration of all factors involved in its causation.

THE SOYA BEAN IN MANCHURIA

G. F. Deasy

ALTHOUGH the soya bean is said to have been used for its oil (as well as for food purposes) by the Chinese as early as 7000 B.C., it is the latest arrival among the world's major commercial oil-seed crops. It was as late as 1908 that the first shipload of soya beans found its way to British and Continental oil mills. It so happened, at that time, that the world oil-seed markets were short of cotton seed, and supplies of linseed were scarcely able to satisfy demands. Consequently, the new soya bean was readily welcomed. From that late beginning the commercial development of the bean has rapidly increased. This process was greatly facilitated by the fact that neither methods nor machinery for previous commercial oil manufacture required alteration in order to employ the bean. Today we find a considerable proportion of the world's vegetable oil requirements being met by the bean, while it ranks among the half-dozen leaders in that field (Figure 1).

Importance of Manchuria in World Production

Of the estimated world production of 351,455,046 bushels of soya beans during 1930, 208,298,428 bushels were grown in Manchuria. In other words, approximately 60 per cent of the world soya bean crop comes from this country alone. It accounts for more than that from all the other countries of the world combined. China Proper is the only significant competitor as a producer of the bean, but even there the amount does not equal one-half of that concentrated in the relatively small country to the north. Manchurian supremacy in soya bean production, therefore, must be acknowledged. The following table shows the estimated production of soya beans in the major producing countries during 1930: ("Report on Progress in Manchuria, 1932," South Manchuria R. R. Co.)

Countries	*Bushels*	*Per Cent*
Manchuria	208,298,428	59.3
China Proper	89,340,000	25.4
Japan	15,238,873	4.3
Korea	20,431,745	5.8
U.S.A.	18,146,000	5.2

The soya bean is adapted to a wide range of climates, although middle-latitude regions, in which the elements of continentality are strongly expressed and which have moderately warm, humid summers, appear to be the most favored for its growth. But such conditions are found over wide areas of the earth's surface, in many of which the cultivation of the bean is unknown or at least relatively unimportant. Why, then, does Manchuria so obviously dominate the soya bean production of the world?

(1) First of all, Manchurian farmers, in common with those of adjacent oriental nations, hold an important advantage over the rest of the world. These regions were the home of the soya bean. Hence they benefit from the accumulated knowledge of centuries of bean culture. The remainder of the world lacks this preparation, and its importance cannot be overestimated. Farmers the world over are by tradition and experience extremely conservative, and it is most difficult to induce them immediately to substitute a new crop for those they are accustomed to grow-

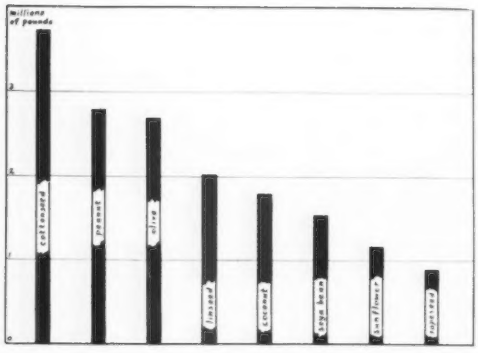


FIGURE 1.—Relative importance of the major vegetable oils, 1929. Data on production of vegetable oils is unavailable. The graph does not represent actual oil extraction but only potential oil content of the output of the respective crops in the leading producing countries. (Source: U. S. Tariff Commission Report No. 41, Second Series, 1932, p. 65.)

ing. Hence, when world demands for a crop suddenly increase, those to whom its culture is familiar generally hold the advantage over those who have not previously grown the crop.

Thus it was with the soya bean. Only the oriental nations (China, Korea, and Japan, as well as Manchuria) were fit, historically, with a background to cope with the extremely rapidly expanding demands for the bean during the present century. This factor, then, has helped them dominate the world bean market today.

(2) Manchuria is favored by still another factor, which helps account for its present superiority. While holding in common with the other oriental nations the advantage of traditional culture of the soya bean, it possesses a climate that appears to be better suited to the growth of the bean plant than that found in any other major portion of the Far East. Although the soya bean can adjust itself to a wide range of variations in climate, an optimum exists. Under tropical or even subtropical conditions such as prevail south of Manchuria, in much of China Proper and Japan, the seeds frequently fail to develop and the pods are empty. In regions with a decidedly short and cool summer, such as those in the north of Manchuria, only the very early varieties will mature and such varieties are dwarf and of low yield. The intermediate Central Plain of Manchuria appears to possess something approaching the optimum climate for the soya bean plant. Consequently, maximum yields per acre are obtainable, and the plant is more economically grown there than elsewhere.

Stewart, in his article "Is Manchuria Vital to Japan," which appeared in the *Bulletin of the Philadelphia Geographical Society* in 1933, gives the following as the average yields per acre for the chief producing countries: 22 bushels per acre in Manchuria; 19 in Japan; 16 in China and the U.S.A.; and 12 in Korea. The "Report on Progress in Manchuria, 1932," of the South Manchuria Railway Company states the following to be the average yields per acre for 1930: 20.4 bushels in Manchuria; 16.6 in Japan; 15.8 in China Proper; 13.2 in the U.S.A.; and 10.5 in Korea.

With reference to this second factor another point calls for attention. The climate of much of Manchuria is apparently less suited to the growth of some of the other world staple crops (wheat, corn, rice, for instance) than are the climates of possible competitors in the soya bean field. Consequently, farmers there tend to produce beans as their major crop, while farmers of other nations lean toward the growth of other crops in preference to the bean.

The *relatively* sparse rainfall and short growing season strictly limit the area available for the profitable production of maize. Likewise the typical Monsoonal rainfall regime of the country, with the resultant light and uncertain precipitation during the growing season for wheat (spring and early summer) and the over-supply of rainfall during

the harvest season for wheat (midsummer) reduces the yield, impairs the quality, and retards the harvesting of that crop. Relatively sparse rainfall, a short growing season, and the lack of experience retard rice production there.

(3) In contrast to the other oriental nations, Manchuria enjoys a unique and a necessary advantage for the successful

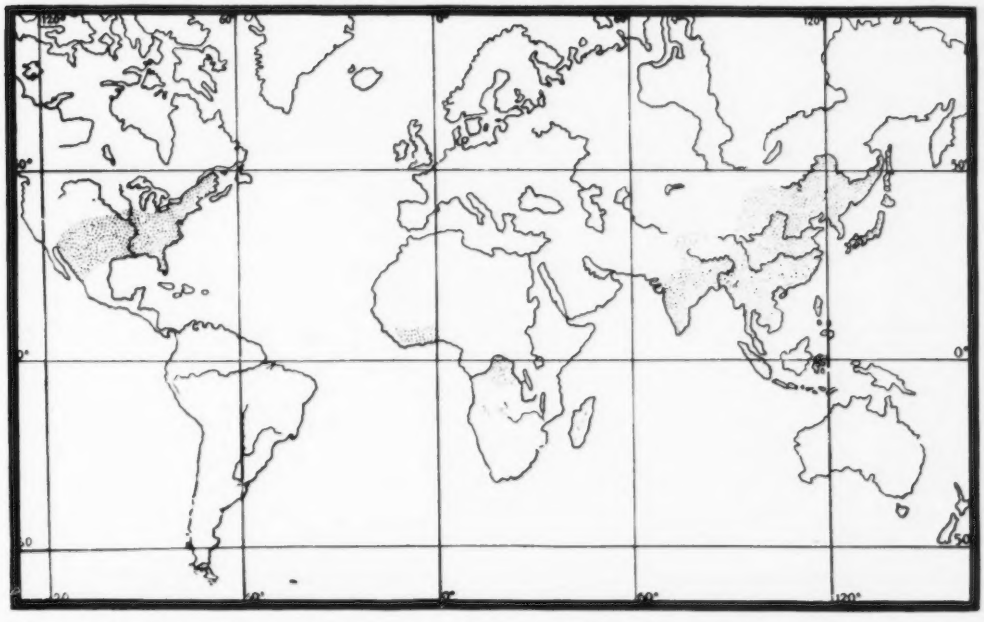


FIGURE 2.—By far the most important soya bean producing centers are found in the Far East—Manchuria, China Proper, Korea, and Japan. Various varieties, of a different sort than those grown in the above countries, are cultivated in Indo-China, India, several of the East Indian islands, and parts of Equatorial Africa. The total output of these latter areas is small, most of it is used locally, and little enters the trade channels of the commercial world. The most rapidly expanding soya bean center during the last several years has been Eastern United States, where energetic steps are being taken to substitute the bean for other less valuable field crops. However, the soya bean industry is still in its infancy in this country. (Source: Ferree, C. J., "The Soya Bean and the New Soya Flour," Heinemann, London, 1929.)

dominance of world soya bean production, namely a surplus of arable land, a quantity above that required for the bare maintenance of her population. Unlike other important crops grown in oriental countries, the soya bean is today a non-subsistence crop, intended mainly for industrial uses and not for food. Consequently it is generally grown on land not needed to maintain a nation's population. Manchuria is the only oriental nation possessing such a surplus of land. Other eastern countries are hard-pressed to find sufficient land to supply food for their teeming millions. Major portions of all the crop land in China Proper, Korea, and Japan are being utilized for food purposes, and are planted in crops that provide direct human nourishment. They have no available surplus of land from which to supply vast quantities of beans to the industrial market. Hence they cannot actively compete with their more favored neighbor as a world producer of beans.

Tea and mulberry are important oriental non-subsistence crops, but unlike the soya bean they require only an insignificant quantity of arable land for their production. Furthermore, they are frequently grown on rugged, hilly,

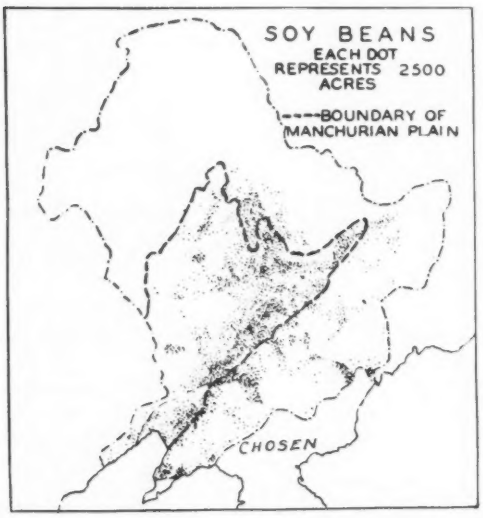


FIGURE 3.—Manchuria leads all the world in soya bean production. The region is the native home of the bean, and soya bean culture there benefits from centuries of experience and hundreds of generations of acquired skill. (Source: Bergsmark, D. R., "Economic Geography of Asia," p. 547, Prentice-Hall, 1935.)

stony, infertile land that could not profitably be used for soya bean or subsistence crop production. Hence, unlike the bean, the mulberry and tea crops do not seriously restrict the total acreage available for the production of food and thus are widely found in both China Proper and Japan.

(4) In addition to possessing the advantages of a more suitable climate and a surplus of arable land, Manchuria has the advantage over China Proper, its nearest competitor, of two additional factors. In the first place, her farmers were not hampered by civil wars and internal strife to the same extent as were the Chinese farmers during that period when the increase in world demand for soya bean products appeared insatiable (1910–1929). Hence, the former found themselves in a position to expand production while conditions were favorable. On the other hand, the evolution of the growing bean industry of China was seriously retarded. Once having gained the leadership, Manchuria has been able to maintain it.

In the second place, her farmers possess the advantage over their Chinese competitors of a better and more rapidly expanding system of railways. This factor is especially important with respect to the soya bean, as that crop is chiefly a market crop subject to shipment. It is not so important when the subsistence crops are considered, because they are largely consumed on or near the producing farms and are not so dependent upon cheap transportation. Consequently, with the relatively low cost per ton-mile of railway haulage at their disposal, the Manchurian farmers could place their bulky bean crop on the markets at a profit, while many of the Chinese farmers, particularly those in the interior, would have had most or all of their profits absorbed by expensive human or cart methods of transportation.

To summarize we see that: (1) the oriental nations are more favored for soya bean cultivation than are the remaining nations of the world, due to the age-old presence of the bean there and the resultant familiarity of the eastern farmer with methods of production; and (2) Manchuria possesses the chief advantages among the oriental nations, because of a more favorable climate, and a unique excess of arable land above subsistence needs. In addition she possessed, during the expansion period of soya bean production, the advantages over China Proper, her chief competitor, of relative political stability and an improved communication system.

IMPORTANCE OF THE SOYA BEAN IN MANCHURIA

Having noted and explained the importance of Manchuria in world soya bean production, one might go a step further and raise the question as to the

importance of the bean within the crop economy of Manchuria itself. What rank does the bean hold among the various crops of that country? Further, what factors help to explain its present status?

The soya bean is the most important crop in Manchuria and at the same time its most distinctive resource. It forms the basis for the outstanding agricultural progress that country has enjoyed in recent decades; it constitutes the mainstay of its rural economy. What wheat is to Canada and coffee is to Brazil, the bean is to Manchuria. It is the crop by which that country is known to the commercial world. Beans are a staple crop on most Manchurian farms. In 1936 they occupied almost 27 per cent of the cultivated land in the country, while their production constituted some 25 per cent of the total output of all crops. No other single crop is found so generally throughout that country, utilizes so large a percentage of its farm land, or contributes so generously to the bulk of its farm produce (Table I).

This predominance of the soya bean in the crop economy of Manchuria is due to a combination of several factors. The first and the most important factor is the commercial status of the bean, which has an *industrial* as well as a subsistence value, contrary to most of the other crops of the country. Of the total bean production in Manchuria for 1930, over 82 per cent was shipped to markets and offered for sale. Only the remaining 18 per cent was consumed by the producer. In contrast, only 13.4 per cent of the aggregate production of all other staple crops was placed on the markets (Manchuria Year Book, 1932–33). As a money crop the only competition comes from wheat. Kaoliang (a grain sorghum), millet, and maize occupy approximately a fourth, a fifth, and a tenth respectively of the land in staple crops but they are almost entirely consumed locally, and only a very small export finds its way to China and Korea. Consequently, the demands for the soya bean are greater and more diversified than are those for the other crops, with the result that prices for the former are relatively high. Thus soya beans yield the highest return per acre, are most profitable, and are naturally preferred by the Manchurian farmer. "With respect to soya beans it is interesting to note that the crop produces greater returns per acre and per labor

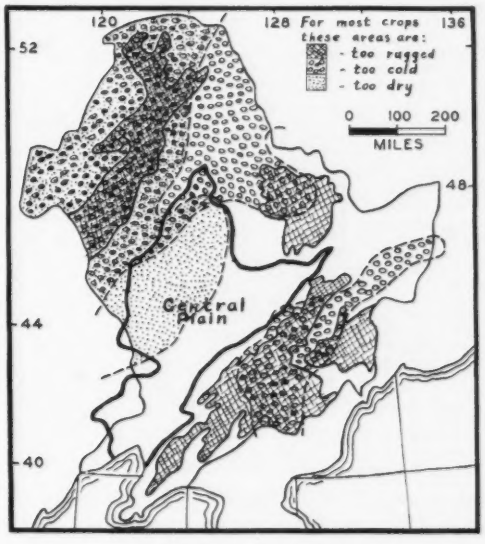


FIGURE 4.—Natural environmental restrictions to extensive agriculture in Manchuria. The areas assumed to be too rugged for the widespread cultivation of most crops are the mountainous portions of Manchuria. Areas receiving less than 400 mm. (15.7 inches) of rainfall annually are assumed to be too dry; areas with less than 140 frost-free days on the average each year are assumed to be "too cool"—i.e., they possess so short a growing season that many crops cannot fully mature. As can readily be seen, the eastern portion of the Central Plain, and the adjacent foothills areas (unshaded) to the east and northeast, are the only extensive tracts of land in Manchuria that are suitable for widespread and reliable agriculture. It is in these areas that the cultivation of the soya bean (as well as most other crops) is concentrated. (Source: modified from maps by Murakoshi and Trewartha, "Land Utilization Maps of Manchuria," *Geographical Review*, Vol. 20, 1930.)

unit than any other Manchurian crop." Young, C. W., *Chinese Colonization and the Development of Manchuria*, Problems of the Pacific, 1929. "Soy beans seem to give the farmer the largest profit and greatest advantage," *Agriculture in North Manchuria*, Chinese Economic Bulletin, V. 15, 1929.

In the second place, the soya bean is apparently well adapted to Manchuria's diverse and changeable natural environment, while many of the other crops of the country are not so favored in this respect. The bean yields well in semi-arid regions, in valleys subject to floods for several weeks during the rainy season, and in northern latitudes having a growing season similar to that of southern Canada. It is less susceptible to frost than either kaoliang or corn, as light frosts have but little effect on the plants. It grows in all kinds of soils and yields fair returns. It seems to thrive remarkably well in a season of drought, and during wet seasons reports frequently state that neither growth nor production is seriously affected. Hence, because of its adaptability to various and fickle environments, the soya bean finds greater favor than other crops with the Manchurian farmer. However, it should be noted that the soya bean is not *entirely* unsusceptible to adverse weather conditions, as is substantiated by the following extract taken from the U.S. Dept. of Agriculture publication, Foreign Crops and Markets, V. 29, No. 9, Aug. 27, 1934. "The 1934 soy bean crop in Manchuria is now estimated at between 4,189,000 and 4,409,000 short tons—A larger crop was originally expected but excessive rainfall in South Manchuria during June and in North Manchuria during July necessitated a downward revision in the estimate."

In the third place the soya bean, a legume, is an important contributor to soil fertility, which fact is of special importance in a country where general farming and consequently animal fertilizer is so conspicuously absent. While this point is not uppermost in the mind of the average peasant, it nevertheless plays a part in fostering the dominance of the soya bean in Manchurian agriculture.

Besides occupying the largest acreage, producing the largest output, and furnishing the principal source of cash for the Manchurian farmer, the soya bean also forms the basis for the large export trade of that country. "In no part of China is there a cash crop which depends so largely on foreign markets." (*Review of the 1930–31 Soy Bean Season in Manchuria*, Foreign Crops and Markets, V. 24, No. 8, Feb. 23, 1932.) During 1930, 68 per cent of the total bean production of Manchuria was exported, in the form of beans, bean-cakes, and bean-oil. At that time the soya bean and its products constituted over 52 per cent of the total value of goods shipped from that country. So enormous are these bean exports that they rank ahead of silk as China's largest export.

TABLE I

MANCHURIAN CROPS—1936

Crop	*Production (metric tons)*	*Area*
Soya Beans	4,175,453	3,415,958
Kaoliang	3,980,665	2,905,796
Millet	3,037,575	2,502,810
Maize	2,099,134	1,294,434
Wheat	882,675	1,085,284
Other Beans	329,966	366,140
Paddy Rice	437,960	173,951
Upland Rice	136,463	114,229
Miscellaneous	1,020,973	962,673
Total	16,100,861	12,821,275

Source. "Japan-Manchoukuo Year Book, 1938."

DISTRIBUTION OF THE SOYA BEAN IN MANCHURIA

In the preceding pages we found that the soya bean output of the world came largely from one country—Manchuria. One may now raise the question: Is bean production relatively uniformly

distributed throughout that country, or is it largely confined to certain districts and absent from others? Furthermore, if concentration exists, how can it be explained?

The most striking feature that is apparent from a dot distribution map of soya bean production in Manchuria (Figure 3) is the concentration of its cultivation within the eastern portion of the Great Central Plain, and in adjacent foothills areas to the east and northeast. Such a distribution, however, is not unique for the soya bean, as the distribution maps of most of the other important crops of the country indicate the same tendency. See Murakoshi and Trewartha, "Land Utilization Maps of Manchuria," *Geographical Review*, Vol. 20, 1930. This merely brings out the fact that on the whole the eastern part of the Central Plain and the adjacent hilly lands to the east and north combine the most favorable set of environmental conditions for crop production to be found in Manchuria. Those areas comprise the heart of that country's agricultural activity, and contain the greater portion of its arable land. They are neither too dry nor too wet, too cold nor too rugged, for widespread crop production (Figure 4); hence it is only natural that the greater part of the area devoted to the soya bean should be found within that part of the country.

Although grown in significant quantities in practically all the eastern portion of the Central Plain, the soya bean reaches its greatest importance in the central and northern portions of that part of the Plain. In the south a smaller percentage of the total acreage is sown to the crop. At least three major causes for this phenomenon can be ascertained. First, the quality of the bean improves and its oil-content increases with progressive distance northward. The northward trend thus created is further intensified by a second factor, namely that competition with other major crops is somewhat less severe in the slightly more rigorous northern portions of the Plain. The ability of the soya bean to mature in a somewhat cooler climate and with a shorter frost-free season and less rainfall than is suitable for kaoliang and maize, two of its chief competitors in the south, immediately increases the amount of land available for its cultivation in the north. It should be noted, however, that the increase in the amount of land devoted to crops other than kaoliang and maize, namely millet and wheat, somewhat reduces the additional amount of land available for bean cultivation—although not sufficiently entirely to offset this factor.

A final factor, that of population pressure, must not be overlooked in explaining the distribution of the bean. The southern part of the Central Plain is densely settled, with population figures per square mile approaching those of the teeming plain of the Hwang Ho. Pressure of population on the land is so great that most of the potential farm areas are given over to the production of subsistence crops. The south then, is the great center of kaoliang—the primary food crop of the Manchurians. In contrast, the central and northern parts of the Central Plain are much less densely populated and more land is available for industrial crops. Here, then, is found the greatest concentration of bean production in the country.

Before leaving the discussion of the distribution of soya bean cultivation in Manchuria, it would be well to point out another characteristic of its localization, namely the concentration of the bean about the railways and the streams (compare Figures 3 and 5). These transportation lines determine the major "channels" wherein bean cultivation is

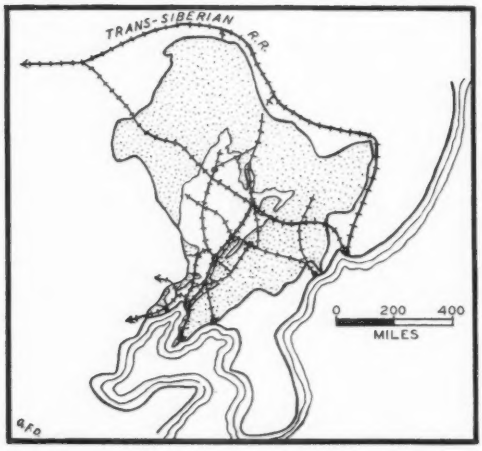


FIGURE 5.—Railroad map of Manchuria, as of 1935. The trunk-line railway for the whole country is the South Manchuria Railroad, which skirts the eastern margin of the Central Plain. This line runs through the economic heart of the country. Along it are located most of the large cities (those indicated by dots on the map are, from south to north, Dairen, Newchwang, Mukden, Ssupingkai, Changchun, and Harbin). Feeder lines branch out from this road toward the east, the west, and the north, thus tapping the agricultural, mineral, and forest resources of those less-productive areas. Crop production both within and outside of the Central Plain follows these railroads (together with the larger streams) in a striking fashion.

chiefly carried on. Adjacent to these "channels" may be, and probably are, regions equally well adapted by environment to the culture of the plant, but without ready access to low cost methods of transport they are still practically unused. It should be emphasized that such intensification of cultivation along lines of transport is not a unique characteristic of the bean alone in Manchuria. The other crops grown there illustrate the principle equally well.

CONCLUSIONS

From the above material the following summary conclusions concerning soya beans and soya bean production in Manchuria can be reached:

The soya bean has recently enjoyed a spectacular rise in importance in the commercial and industrial world, and today supplies a considerable proportion of the world's vegetable oil requirements.

Manchuria is the world's most important source of soya beans, its predominance being due to: (a) the historical factor of early oriental familiarity with the production of the crop; (b) a climate that is better adapted to bean production than that of adjacent eastern countries; (c) a unique excess of arable land (for the Far East) above that necessary for subsistence purposes; (d) a period of relative political stability (compared with China Proper) during the time of rapidly expanding demands for the bean; and (e) fairly good transportation facilities (again compared with its nearest competitor, China Proper) for getting the bulky bean harvest cheaply to world markets.

The soya bean is the most important crop in Manchuria, its significance being attributable to: (a) its *industrial* as well as subsistence value; (b) its adaptability to the diverse and changeable natural environment of the country; and (c) its contribution to soil fertility.

The distribution of the soya bean within Manchuria shows certain marked features: (a) the concentration of production within the eastern half of the great Central Plain (and adjacent hill land areas); (b) the greater significance of bean production in the northern and central portions of the eastern half of the Plain, as contrasted with the southern part; and (c) the significance of lines of transportation in still further localizing production. Each of these three features can be satisfactorily explained in terms of certain features of the natural and cultural environments.

DISTRIBUTION OF SUGAR CANE PRODUCTION IN CUBA

Helen M. Boyer

THE distribution of sugar cane production in Cuba suggests definite relationships to geographic and economic conditions. The fact that sugar cane is cultivated extensively in all the provinces, with the exception of Pinar del Rio, indicates that these provinces have large areas well suited to its culture. An analysis of cane production shows close relationships between the distribution and rock formations, relief of the land, annual rainfall, seasonal distribution of precipitation, soils, and the shape and coast line of Cuba. Among the more important economic conditions which influence the distribution of sugar cane are the momentum of an early start in the older sugar regions, transportation facilities, population density and labor, valorization, and land use.

Sugar cane was brought to Cuba by its first governor, Diego Velasquez, in the second decade of the sixteenth century. Following its introduction, the culture of cane continued without appreciable increase until the middle of the eighteenth century. Since that time, the development of sugar culture has had three long periods of rapid growth, culminating in the middle seventies, 1894 and 1929 respectively, and interrupted by periods of recession, each about ten years long. During the periods of expansion, sugar cane culture spread to all six provinces of Cuba; aided by many improvements in methods of culture and manufacture, production increased to more than five million tons in 1929.

Distribution of Cane Culture in Colonial Times

The sugar cane industry began to develop rapidly in the later part of the nineteenth century, although its progress had been exceedingly slow during the three preceding centuries. Sugar cane, introduced into the provinces of Habana and Matanzas, remained centered there for more than a century. The early cultivation of sugar cane was probably limited to areas near the settlements along the coast. In 1760, sugar was being exported from Habana, Matanzas, Santiago de Cuba, Trinidad, Baracoa, and Mariel; consequently the areal distribution of sugar cane was apparently limited to the vicinity of these ports. The province of Habana probably ranked first in production. In 1819 the trans-Atlantic export of sugar from Matanzas did not exceed one-thirteenth of that from Habana, and in 1823 it was one-tenth. During the period of expansion, beginning about 1834, cane culture spread to a number of areas of the island, and several fishing ports developed into well-frequented harbors for the shipment of sugar. By 1894, the area of sugar cane production extended from the eastern third of Pinar del Rio to the eastern half of Camaguey; the richest and most extensive area was in the provinces of Habana, Matanzas, and Santa Clara. Matanzas, with the greatest number of sugar plantations, ranked first in production at that time. The number of sugar plantations in 1894 in the various provinces of Cuba was: Pinar del Rio, 70; Habana, 166; Matanzas, 434; Santa Clara, 332; Cama-

guey, 5; Oriente, 93; total, 1,100. The largest cultivated area per farm, 1.2 *caballerias*, was also in Matanzas (the *caballeria* is equal to 33.16 acres). Furthermore the rural population on farms was greatest in Matanzas in 1899; there it averaged 35 persons per farm, whereas in Camaguey it averaged 26 and in Oriente 13; in Cuba as a whole the average was 18.

By 1899 each province of Cuba produced sugar cane (Table I).

TABLE I

DISTRIBUTION OF SUGAR AREA BY PROVINCES IN 1899

Province	*Cordels*	*Percentage of Sugar Area of Cuba*	*Percentage of Cultivated Land in Provinces in Sugar*
Santa Clara	1,735,000	41.9	71.3
Matanzas	1,245,501	30.1	78.4
Oriente	691,100	16.7	34.5
Habana	279,444	6.7	27.0
Camaguey	105,500	2.5	34.7
Pinar del Rio	85,471	2.1	6.1

Report on the Census of Cuba, 1899, United States War Department, Washington, 1900, p. 549.

Assuming that the production is roughly proportional to the area under cultivation, it appears that Santa Clara produced not less than 41.9 per cent of the output of the island and Matanzas 30.1 per cent. Considering the relative areas of the two provinces, it is seen that Matanzas was, in proportion to its area, of more importance in the sugar industry than Santa Clara, although the latter ranked first in production. Sugar cane occupied 47.3 per cent of the area devoted to the cultivation of crops in 1899, when the total area of land in sugar was 4,142,016 *cordels* (324 *cordels* equal 1 *caballeria*, approximately 10 *cordels* equal 1 acre). The proportion of the cultivated area planted to sugar cane differed widely in different provinces, showing a corresponding difference in the relative importance attached to this crop in different portions of the island. Table I shows the percentage of the cultivated land planted to sugar cane in each province. Considering the area of cultivated land, Matanzas had the most intensive production of the provinces of Cuba, nearly four-fifths of its cultivated land being devoted to the culture of sugar cane. In Santa Clara nearly three-fourths of the cultivated area was thus used, while in Pinar del Rio only one-sixteenth of the cultivated land was in sugar cane.

Statistics were compiled during the Census of 1899 in regard to the number, capacity, and production of the centrals (Table II). These are considered fairly satisfactory in spite of the conditions of the sugar industry at the close of the Spanish-American War. Many mills were in ruins and others had been damaged; none were grinding as the census was not taken during the harvesting period.

The average size of the sugar plantations in Cuba varied greatly in different districts. Their number and average size in *cordels* are given in Table II, which shows that many of the centrals probably received cane from several plantations.

RECENT DISTRIBUTION OF CANE CULTURE IN CUBA

Developments since 1899 have brought about a significant change in the location and distribution of the

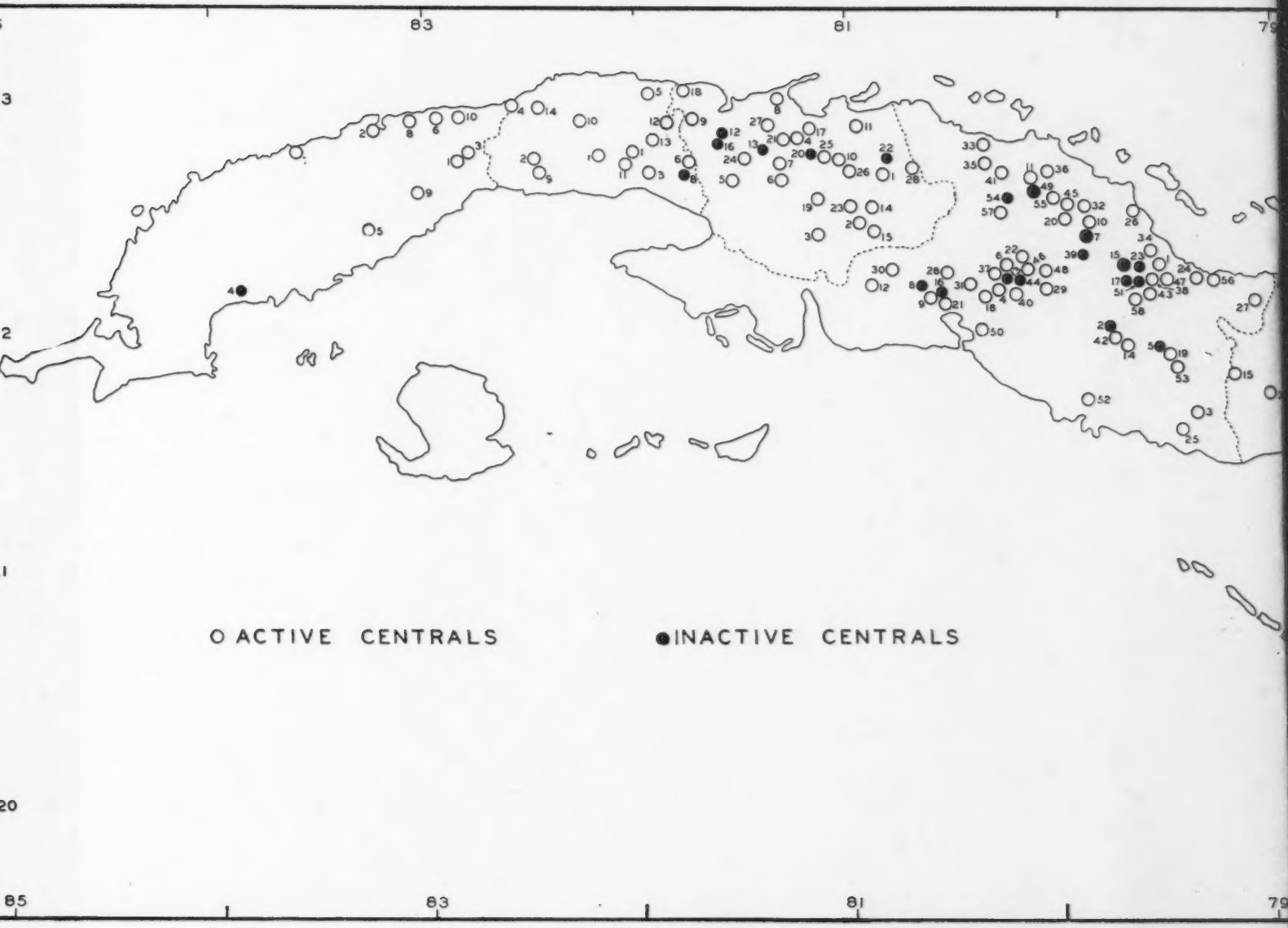
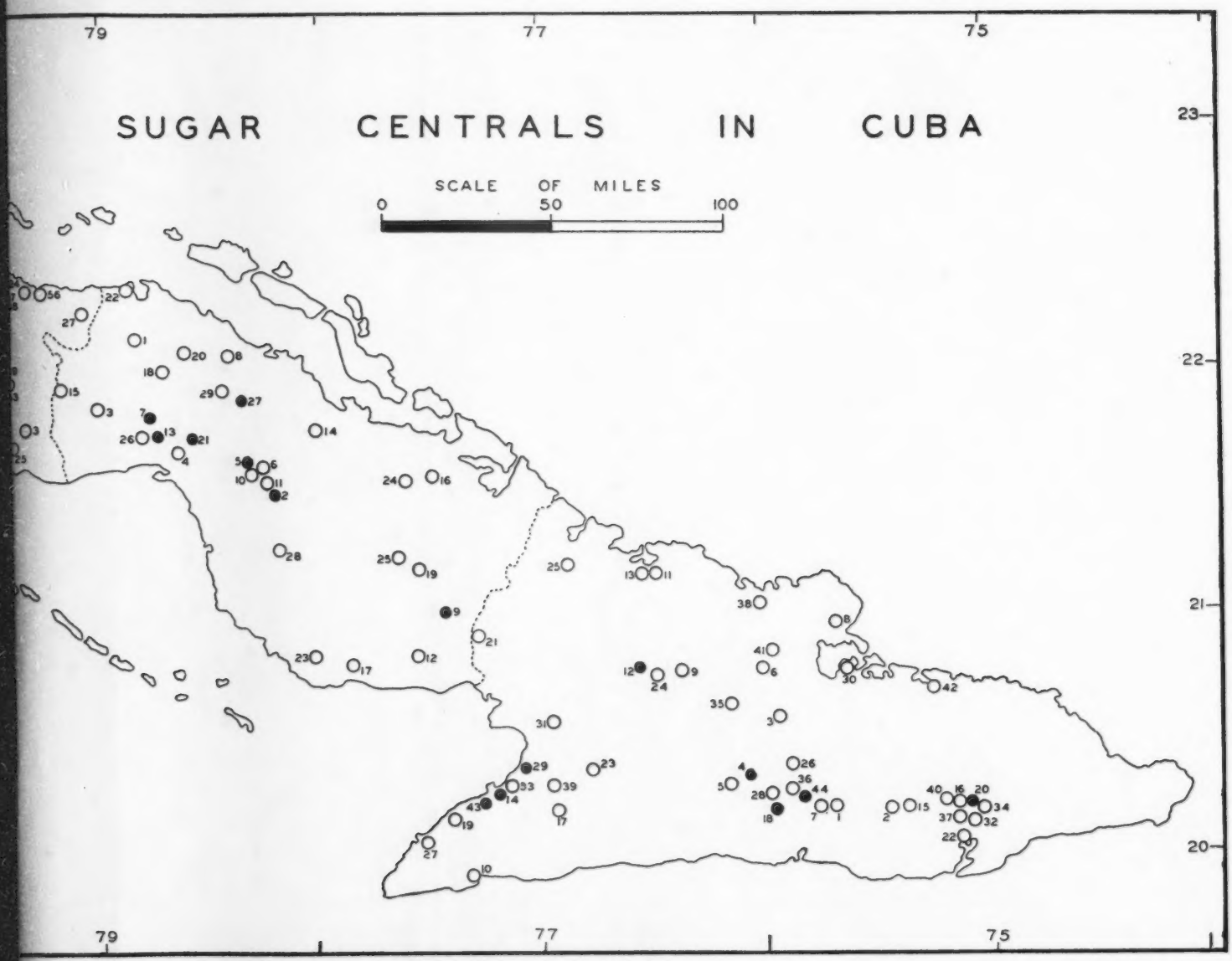


FIGURE 1.—The active centrals, as represented on this map, are those which were produ
down between 1928 and 1937. Many factors operated in causing 36 mills to close durin
infertile, stony or thin soil areas or from rather rough land, closed because of inability to c
and other mills were forced out of business because of inefficient methods and machinery.
over by enlarged and more modern centrals.



were producing in 1937, while the inactive centrals are those that closed close during this period; many of the mills that drew cane from rather inability to compete with centrals depending upon more productive areas machinery. Still other centrals closed because their cane lands were taken

cane areas of Cuba. In colonial days, sugar was produced chiefly in the western provinces, with the exception of Pinar del Rio. In recent years new centrals have been largely located in the east, which has been opened up by railroads since Cuba became independent. The virgin lands of the eastern provinces give greater yields than those long under cultivation in the west. It is in this area, especially in Oriente and Camaguey, that American investment has been chiefly made.

In recent years sugar has been produced by 147 active centrals (Figure 1). The province of Oriente ranks first in production, the other provinces ranking in order from east to west (Table III). The distribution of production of sugar cane is shown by the dot map (Figure 2).

Relation of Cane Production to the Rock Formations:—Considering the island of Cuba as a whole, sugar cane is grown primarily on five different geologic formations. They include Eocene-Oligocene, alluvium, Cretaceous, diorites, and granitoid rock formations. Approximately 76 per cent of the total production is on Eocene-Oligocene limestone areas because of its permeability and high lime content. The very thick limestone and marl series with occasional beds of calcareous sands of the Upper Oligocene age are by far the most widespread geologic formation in Cuba, and are exposed over approximately one-half of the island. They originally extended from Pinar del Rio to Oriente excepting only the highlands of Pinar del Rio, the Trinidad Mountains, and occasional high peaks along the axial portion of the island. Lithologically, the material is either soft limestone or calcareous marl. Because of their permeability these formations in general are well drained; in some areas the water

TABLE II

SUGAR CENTRALS AND PLANTATIONS IN 1899

Province	*Centrals*			*Plantations*	
	Number	*Cane Capacity*[1]	*Daily Production*[2]	*Number*	*Average Size in Cordels*
Habana	20	858,050	6,025	1,099	254
Matanzas	72	3,342,200	23,406	2,133	584
Pinar del Rio	7	118,700	785	178	480
Camaguey	3	170,000	1,180	1,419	74
Santa Clara	73	3,512,600	22,750	5,474	317
Oriente	42	752,542	7,261	5,218	132
Total	217	8,754,092	61,407	15,521	307

[1]Capacity in *arrobas;* an *arroba* equals 25 pounds.
[2]Production in bags of 325 pounds (Spanish) or 329.6 pounds (English).

TABLE III

CENTRALS AND SUGAR PRODUCTION BY PROVINCES IN 1937

Province	*Area*	*Number of Centrals*	*Production (Bags)*	*Per Cent of Production*
Oriente	12,468	36	17,616,263	39.2
Camaguey	10,500	22	12,486,621	27.7
Santa Clara	9,560	44	7,727,751	17.2
Matanzas	3,700	23	4,220,628	9.4
Habana	2,772	13	2,186,757	4.9
Pinar del Rio	5,000	9	717,411	1.6
Total	44,000	147	44,955,431	100.0

UNIV. OF MICH.

descends so readily and to such depths that they are rendered unfit for cultivation.

Much less sugar is produced on the other rock formations. About 10 per cent of the sugar is produced on alluvium of the Pleistocene age. The swampy areas along the coast and the plains covered with gravel, derived from the mountains, constitute the principal areas of this formation which is unsuited to the culture of sugar cane. Approximately 8 per cent of the sugar is grown on the Cretaceous formations which are generally severely faulted, folded, and in places greatly metamorphosed. They consist of calcareous strata of glauconitic limestones, somewhat clayey in composition and containing magnesian marls. The Cretaceous formations also include shales, sandstones, and conglomerates. In each province, except Pinar del Rio, some sugar cane is produced on dioritic basalt and serpentine formations. These are the most ancient rocks in Cuba, and are generally found along the protaxis of the island. They are igneous in origin, constituting the base upon which all the succeeding geologic formations, with the possible exception of some doubtful Paleozoic rocks in the vicinity of Trinidad, have been laid. Altogether about 5 per cent of the sugar of Cuba is grown on these formations. No sugar is produced on Jurassic, Triassic, or Paleozoic formations.

Relation of Cane Production to Relief:—A comparison of the relief and sugar distribution maps shows a striking correlation between sugar producing areas and elevation and relief (Figure 3). Approximately 68 per cent of the sugar is produced on land less than 300 feet in elevation and 31 per cent on land between 300 and 1,000 feet in elevation (Table IV). Hence 99 per cent of the sugar cane grows on land less than 1,000 feet in elevation and less than 1 per cent (.0069) is grown on land over 1,000 feet. The higher lands and mountains are not suitable for the culture of sugar cane because the average temperature is lower, the range of temperature is greater, rainfall is heavier, erosion is more rapid, and transportation is difficult because the surface is rough and mountainous. However, only the eastern portion of the island is distinctly mountainous, and the total mountainous area does not exceed one-fifth of the island.

TABLE IV

ELEVATION AND SUGAR PRODUCTION BY PROVINCES

Elevation	*0–300 Feet*	*300–1,000 Feet*	*1,000–2,000 Feet*
Province	*Tons*	*Tons*	*Tons*
Pinar del Rio	98,000	8,000	.....
Habana	80,000	134,000	.....
Matanzas	272,000	26,000	.....
Santa Clara	370,000	144,000	6,000
Camaguey	554,000	138,000	4,000
Oriente	390,000	356,000	8,000
Total	1,764,000	806,000	18,000
Per Cent	68.	31.	.0069

Although Cuba is a part of the Antillian Mountain system, many sections of it have been reduced to low, gently undulating plains or rolling hills. These level or nearly level lands slope gently from the central divide. Insofar as relief is concerned, over 80 per cent of Cuba, according to general estimates,

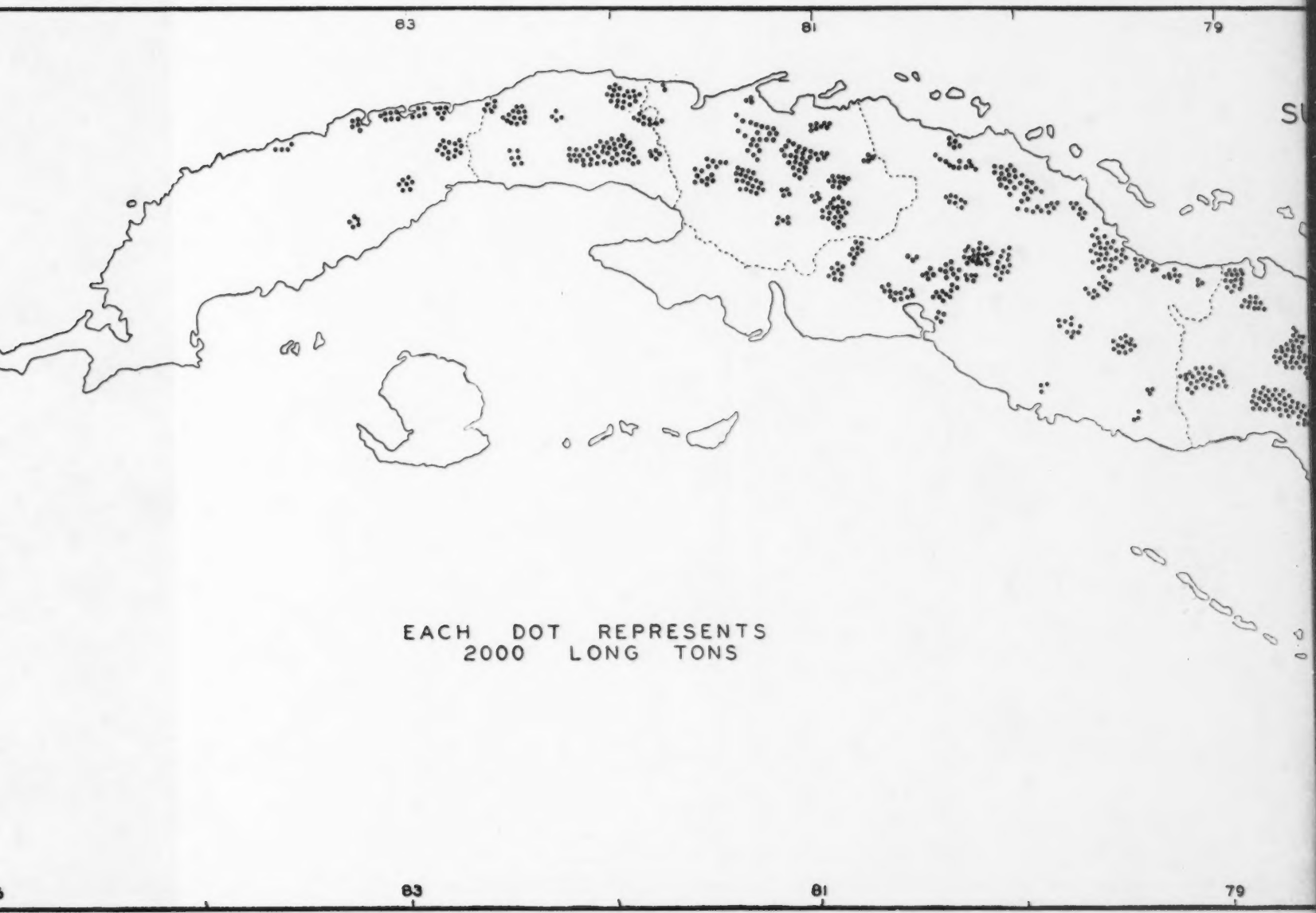
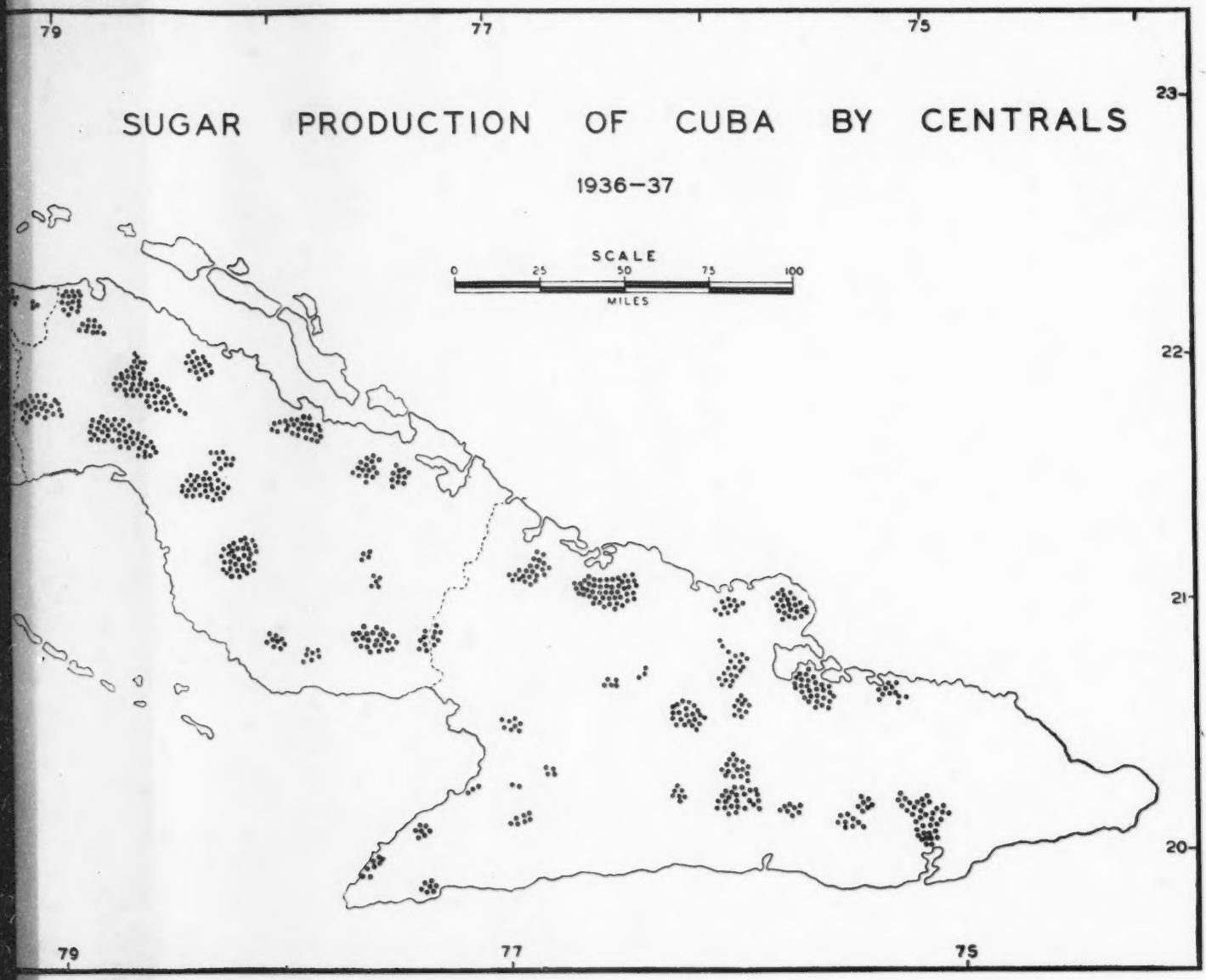


FIGURE 2.—As statistics of sugar acreage or production by small political divisions are not available in making the map of distribution of sugar production in the island. For the actual distribution of climate, soils, vegetation, and on location with reference to the centrals and ports was made.



are not available, the production of sugar by centrals has been used
distribution of the dots all information available on geology, relief,
was made.

is actual or potential agricultural land, and 10 per cent more is equal in quality to land that produces good crops in Java, China, and Japan.

Sugar production on the plains of Cuba varies greatly in the different provinces. No sugar cane is grown in the north central part of Habana province as much of the land near the city of Habana is devoted to dairying and market gardening. Much sugar is produced on the Colon plain in Matanzas. Although plains cover the greater part of Santa Clara and sugar cane production is heavy, the surface is broken by various mountain groups and production is much scattered. Great quantities of sugar cane are grown on the lower parts of the plain in both Camaguey and Oriente but the plains of Oriente (including the valley of the Rio Cauto) surpass those of Camaguey in production.

Much of the great lowland area of Cuba is underlain by porous limestone which, with the gradual slope of most of the land, gives excellent drainage. Often the surface waters find underground passages and surface streams are absent. Streams are numerous, however, nearly 200 entering the sea. They are practically all normal to the coast but have no considerable length or volume owing to the shape of the island. The Rio Cauto, which flows through Oriente in a broad westward pitching syncline, is the largest. Terraces and swamps are conspicuous relief features of the coastal regions but have no part in the sugar production.

Relation of Cane Distribution to Climatic Conditions:—The location of Cuba on the outer margin of the tropics gives it an ideal climate for growing sugar cane. Cuba lies in the belt of the northeast trade winds throughout the year, so there is relatively little difference in the strength or direction of the winds from month to month. Tropical hurricanes are occasional but not frequent as the storms go on either side of the island due to its northwest-southeast orientation. Uniformity throughout the year and from year to year are outstanding characteristics of the temperature. The average annual temperature in lowlying areas is about 77 degrees Fahrenheit. Mean monthly temperatures of January and February range from 67.5 degrees to 75 degrees Fahrenheit, while those of July and August range from 77.7 to 82.8 degrees. Hence the temperatures of the entire island are suit-

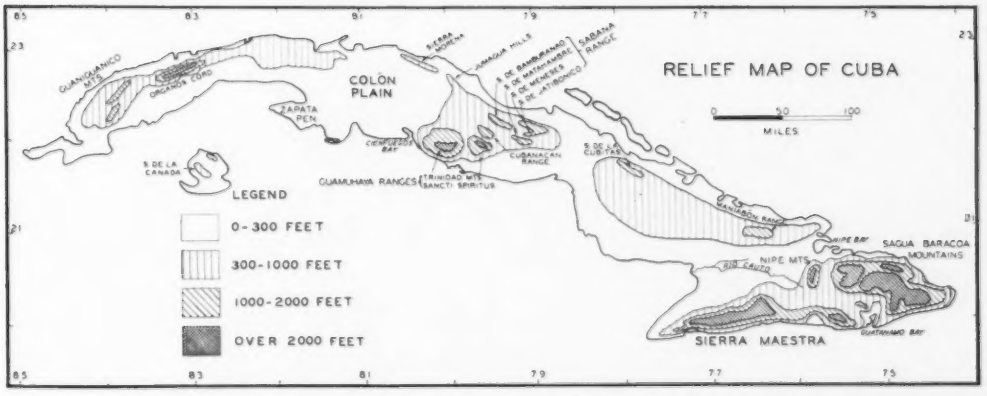


FIGURE 3.—Extensive areas of level to rolling plains and the somewhat more rolling low hills offer fertile, well drained soils and excellent conditions for the planting, tilling, harvesting, and transportation of the cane. The absence of sugar cane production is conspicuous in the major mountain areas of the island. (Courtesy of Thomas W. Chamberlin.)

TABLE V

RELATION OF CANE PRODUCTION TO ANNUAL RAINFALL

Inches	30–35	35–40	40–45	45–50	50–55	55–60	60–65	65–70
Province	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*
Pinar del Rio	....	.....	38,000	10,000	.....	46,000	12,000	20,000
Habana	....	.....	.....	34,000	64,000	68,000	28,000	.....
Matanzas	....	.....	.....	.....	94,000	142,000	62,000	.....
Santa Clara	....	.....	.....	88,000	244,000	156,000	32,000	.....
Camaguey	....	.....	.....	204,000	276,000	160,000	56,000	.....
Oriente	8,000	12,000	134,000	316,000	220,000	64,000	.....	.....
Total	8,000	12,000	172,000	652,000	898,000	636,000	190,000	20,000
Per Cent	.4	.6	7.	25.	35.	25.	7.	1.

able for the growth of sugar cane, with the possible exception of regions of high elevation. Constant high temperatures mean that Cuba is free from frost and can get from four to six ratoon crops from one planting, thus lowering the cost of production. Ten to eighteen months are required for cane to mature with the highest sugar content and in places where frosts occur, cane must sometimes be cut before it is ripe.

The average annual rainfall for Cuba ranges from 25 to more than 70 inches. The interior and higher portions receive more than the low coastal areas (Figure 4). Regions having 50–55 inches of rainfall produce 35 per cent of the sugar, and regions having 45–50 and 55–60 inches produce 25 per cent each. Thus areas with a precipitation between 45 and 60 inches (Table V), produce 85 per cent of the sugar of Cuba. About 7 per cent is grown on regions having 30–45 inches and 8 per cent on regions having 60–70 inches. One per cent is produced on lands receiving 30–40 inches. No sugar is grown on lands having less than 30 or more than 70 inches, but these areas form a small part of the island as only the Sierra de los Organos receives more than 70 inches and the region near Guantanomo Bay less than 30 inches.

Not only is the total annual rainfall suitable for the production of sugar cane but the seasonal distribution is also fav-

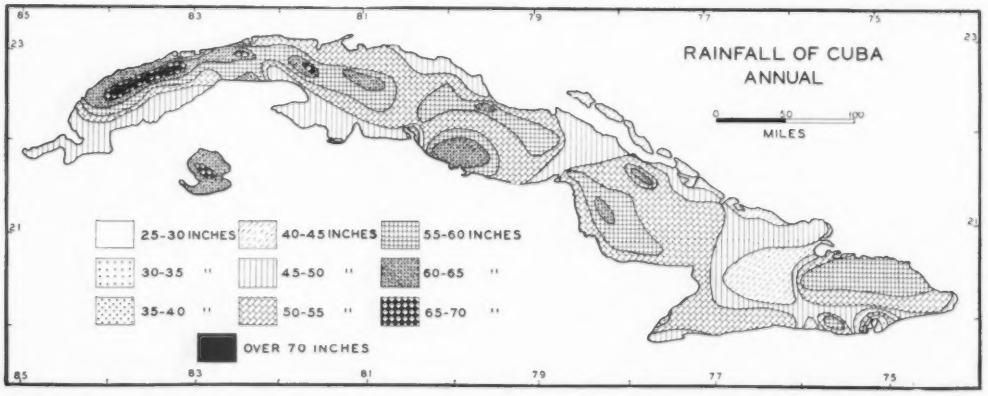


FIGURE 4.—One of the more important factors in accounting for the distribution of sugar farming in Cuba is the total annual rainfall received by different regions. Much of Cuba has an annual precipitation of 45–60 inches. This amount of annual precipitation seems to be about ideal for sugar cane culture without irrigation as very little sugar is grown on lands having less than 35 inches or more than 65 inches. (Courtesy of Thomas W. Chamberlin.)

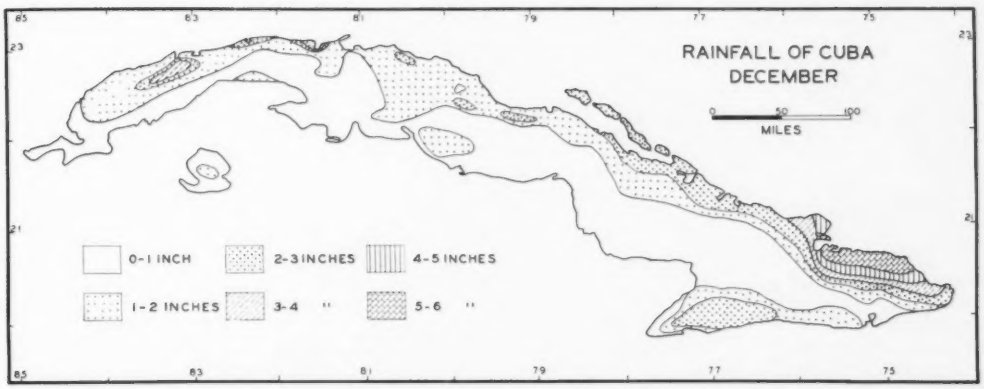


FIGURE 5.—During the month of December very little of the island of Cuba receives more than two inches of rain. Even so 55 per cent of the sugar of Cuba is produced on land having less than one inch of rain in December and 33 per cent on land receiving from one to two inches, making a total of 88 per cent on areas with less than two inches of rainfall in December. The dry ripening and harvesting season is especially significant in cane culture because it is during the dry months that the sucrose content of cane increases from about 9 per cent to about 15 per cent, and because the lower temperatures, the small amount of rainfall, the solid terrain, and the large amount of sunshine during the dry season all facilitate the harvesting and transportation of cane. (Courtesy of Thomas W. Chamberlin.)

orable. The rainfall regime over most of Cuba displays a double summer maximum in May-June and September-October. Abundant rains fall from April to November when the growing cane needs much moisture. At this time the cane grows stalks and leaves and stores little sugar. During the dry season—December to April—the cane ripens and the sucrose content increases from 9 per cent at the beginning of the grinding season in December to 15 per cent near the end of the grinding season in early May. With the coming of the wet season the sucrose content decreases to 9 per cent or less.

Several other effects of the dry season are important. Cane spoils less quickly, and conditions for labor are better because of slightly lower temperatures and strong trade winds. The dry terrain facilitates the use of oxcarts in transporting the cane to the loading stations. For these reasons most sugar cane is grown in regions with wet and dry seasons rather than in places having an even distribution of precipitation throughout the year.

The rainfall maps for December, January, February, and March and the accompanying table further emphasize the effect of the dry season. From 50–75 per cent of Cuba receives less than one inch of rainfall during the months of December and February. Fifty-five per cent of the sugar is grown on land receiving less than one inch of rain in December and 33 per cent on land receiving 1–2 inches (Figure 5), making a total of 88 per cent of the production on areas having less than 2 inches of rainfall. The production of the remaining areas diminishes as the amount of rainfall increases (Table VI).

In January there is a slight increase in precipitation throughout the island (Figure 6). Only 15 per cent of the production is on land with less than 1 inch of rain, while 60 per cent is on land having 1–2 inches. Thus land having less than 2 inches of rain produces 75 per cent of the sugar (Table VI). The difference between the correlations for December and January is due to the fact that practically all of Cuba receives 1–2 inches of rainfall in January. Nev-

ertheless, the greater part of the sugar cane is grown on the drier sections.

From 50–75 per cent of Cuba receives less than 1 inch of precipitation during February, the driest month of the year (Figure 7). Seventy-three per cent of the cane production is on land receiving less than 1 inch of rain and 25 per cent on land having 1–2 inches, thus making a total of 98 per cent of the production on land having less than 2 inches of rainfall in February (Table VI).

TABLE VI

RELATION OF SUGAR PRODUCTION TO MONTHLY RAINFALL DURING DRY SEASON

(Percentage of Sugar Production in Areas with Following Rainfall Amounts)

Months	*Inches*					
	0–1	*1–2*	*2–3*	*3–4*	*4–5*	*5–6*
December...	55.	33.	6.5	.5	2.5	2.5
January.....	15.	60.	18.	6.	1.	.0
February....	73.	25.	2.	.0	.0	.0
March.....	27.	66.	7.	.0	.0	.0

In March, 27 per cent of the cane production is on land having less than 1 inch of rainfall and 66 per cent on land receiving 1–2 inches. This makes a total of 93 per cent on areas having less than 2 inches of rainfall (Table VI).

However, March is similar to January in the amount of precipitation, as most of the island receives 1–2 inches during this month (Figure 8). Although the greater percentage of sugar production is on those areas which receive less than 1 inch of rainfall in December and February, and on regions having 1–2 inches in January and March, by far the greatest percentage of the sugar cane is confined consistently to the drier areas of the island throughout the dry season.

Relation of Cane Production to Vegetation:—The types of vegetation in Cuba include grassland and savanna, sub-tropical rain forest, sub-tropical thorn forest, Atlantic barrens, and mangrove swamps. The regions of sub-tropical rain forest were formerly extensive throughout the island, covering the mountains and hills and most of the land not in savanna. In 1899, it was estimated that 27 per cent of Cuba was covered with large timber and 14 per cent with small timber; thus 41 per cent of the island was forested. The major part of this was in the eastern part of the island. When cleared, the regions of sub-tropical rain forest afford the

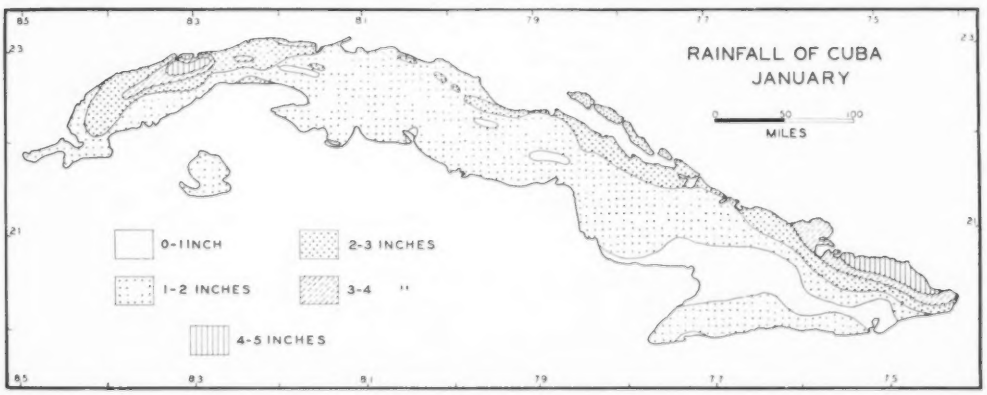


FIGURE 6.—During the month of January only a very small part of the island of Cuba receives less than one inch of rainfall. Most of the island receives between one and two inches of rain. Only 15 per cent of the production of sugar is on lands having less than one inch of rainfall in January, whereas 60 per cent is on land having one to two inches, giving a total of 75 per cent of the production on land having less than two inches of rainfall for January. The difference between the correlation of December and that of January is due to the fact that practically all of Cuba receives one to two inches in January. (Courtesy of Thomas W. Chamberlin.)

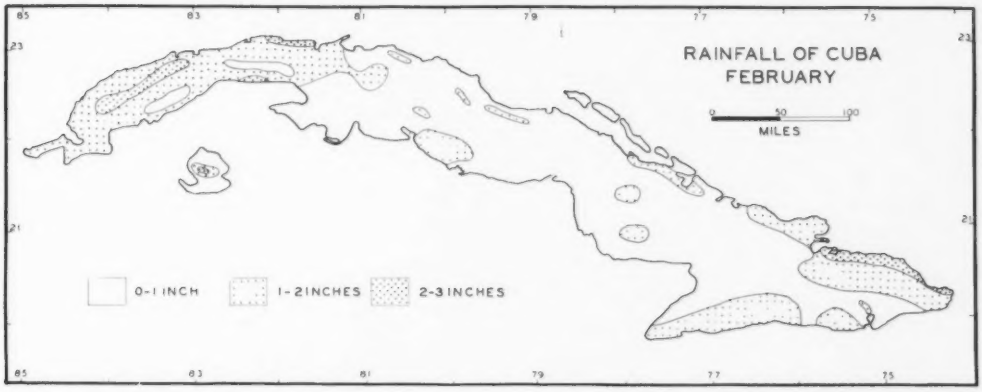


FIGURE 7.—Nearly three-fourths of the island of Cuba receives less than one inch of precipitation during the month of February. For the island as a whole February is the driest month of the year. Seventy-three per cent of the cane production of the island is on land having less than one inch during February and 25 per cent on land having from one to two inches, giving practically all of the sugar production of the island on land having less than two inches of rainfall during February. (Courtesy of Thomas W. Chamberlin.)

most productive cane land. American investments in land since 1898 have been largely in Camaguey and Oriente on lands of this type which were available for exploitation. Approximately 54 per cent of the sugar production is on land originally covered with sub-tropical rain forest.

The grassland and savanna areas have the advantage of being easily prepared for planting. Approximately 40 per cent of the sugar cane is produced on land originally covered with this type of vegetation. Some authorities state that the more or less timberless savanna lands have generally been avoided by Cuban farmers from earliest times. The reason given is that the scanty vegetation characterizing the savanna areas is attributable in such a climate as that of Cuba to unfavorable soil, a lack of moisture, or to a combination of these.

Areas of sub-tropical thorn forest are located in northern Habana and south of the Sierra Maestra. About 6 per cent of the sugar cane is produced on land originally covered with this type of vegetation. Probably no sugar cane is grown in regions of Atlantic pine barrens, and none is produced in the mangrove swamp lands which border the northern and southern coasts.

Relation of Cane Distribution to Soils: —As the factors of geology, relief, climate, and natural vegetation are favorable over extensive areas of Cuba, the factor of soil becomes dominant in the selection of land for sugar cane production. Modern soil science has shown that the suitability of the soil to a certain crop is one of the principal factors determining the success or failure of its production. "It is manifest that a really good and fertile soil would logically be regarded as the first and most important requisite. This is particularly true, since a natural combination of conditions which has made for the development of a good soil will usually prove satisfactory for good plant growth" (Bennett, H. H. and Allison, R. V., Soils of Cuba. Tropical Research Foundation, Washington, 1928. P. XIX).

In Cuba sugar cane is grown on twenty-eight types of soil, the majority of which are derived from deeply disintegrated limestones formed during the Eocene-Oligocene periods (Figure

TABLE VII

RELATION OF CANE PRODUCTION TO SOILS

Soil Types	*Pinar del Rio Tons*	*Habana Tons*	*Matanzas Tons*	*Santa Clara Tons*	*Camaguey Tons*	*Oriente Tons*	*Total Tons*	*Per Cent*
MA	28,000	152,000	268,000	116,000	286,000	8,000	858,000	33.
MC	.....	32,000	.....	80,000	154,000	46,000	312,000	12.
AC	.....	.....	.....	.....	.....	202,000	202,000	8.
H	.....	30,000	8,000	96,000	.....	52,000	186,000	8.
SC	.....	.....	.....	70,000	22,000	48,000	140,000	5.
CH	.....	.....	.....	.....	.....	100,000	100,000	4.
PAL	.....	.....	.....	.....	.....	86,000	86,000	3.
TU	.....	.....	.....	.....	40,000	46,000	86,000	3.
V	.....	.....	.....	26,000	54,000	.....	80,000	3.
LA	.....	.....	.....	64,000	4,000	.....	68,000	3.
EM	.....	.....	.....	26,000	34,000	.....	60,000	2.
HL	.....	.....	.....	36,000	.....	16,000	52,000	2.
Bg	.....	.....	.....	.....	.....	50,000	50,000	2.
JA	.....	.....	.....	.....	46,000	.....	46,000	2.
PR	38,000	.....	.....	.....	.....	.....	38,000	2.
GU	.....	.....	.....	.....	.....	34,000	34,000	1.
A	.....	.....	.....	.....	.....	32,000	32,000	1.
C	.....	.....	.....	.....	30,000	.....	30,000	1.
SM	.....	.....	4,000	.....	20,000	6,000	30,000	1.
NA	24,000	.....	.....	.....	.....	.....	24,000	1.
VG	16,000	.....	.....	.....	.....	.....	16,000	..
FR	.....	.....	.....	.....	.....	14,000	14,000	..
RM	.....	.....	.....	.....	.....	14,000	14,000	..
HE	.....	.....	10,000	.....	.....	.....	10,000	..
MP	.....	.....	4,000	.....	4,000	.....	8,000	..
PA	.....	.....	.....	6,000	.....	.....	6,000	..
SL	.....	.....	4,000	.....	.....	.....	4,000	..
SS	.....	.....	.....	.....	2,000	.....	2,000	..

9). The residual loams, both red and black, have the characteristic fertility of such soils. Some parts of Cuba have been farmed for 400 years, but very little of the sugar land is artificially fertilized. Although the method of production is extensive rather than intensive, the yield of sugar cane per acre is higher than in India but much less than on the irrigated lands of Hawaii, which produced 7.64 tons per acre in 1935.

The yields of sugar per acre vary greatly, depending upon whether the crop taken is a plant crop or a ratoon crop, the age of the cane when cut, the weather conditions, and the variety of cane. The productivity of the soil under extensive methods of cultivation is one of the chief factors in the low net cost of the finished product in Cuba.

Approximately 70 per cent of the sugar cane of Cuba is grown on six types of soil. Of these, the Matanzas clay soils rank first, producing 33 per cent of the sugar cane (Table VII). These soils, which are the most extensive group in the island, are highly prized for crop production and are largely in use, having shown a marked durability under cultivation. This soil is found largely in the western provinces where it produces 26 per cent of the sugar in Pinar del Rio, 71 per cent in Habana, and 89 per cent in Matanzas. Smaller areas of Matanzas soil produce 22 per cent of the sugar in Santa Clara and 41 per cent in Camaguey. Only one area is located in Oriente but it produces 8,000 tons of sugar.

The importance of the Matanzas clay is further emphasized by the fact that in addition to the 33 per cent produced on Matanzas clay alone, approximately 14 per cent is produced on MC, SM, and MP, in each of which Matanzas clay is one of the important soil types.

A group of soils (MC) which include Matanzas, Santa Clara, Camaguey, Francisco, Habana, and Oriente clays

produce 12 per cent of the total sugar of Cuba.

Fifteen per cent of the sugar cane of both Habana and Santa Clara is grown on this soil. Camaguey has the most extensive area of MC, which produces 22 per cent of the sugar of that province; here the Central Vertientes, which has the largest production of any central in Cuba (473,497 bags), is located. A few small areas of MC produce 6 per cent of the sugar of Oriente.

The sugar of Oriente is grown on this type of soil.

The SC group of soils including Santa Clara, Camaguey, Oriente, and Habana clays, ranks next in importance with 5 per cent of the total production. This soil produces 13 per cent of the sugar in Santa Clara, 3 per cent in Camaguey, and 6 per cent in Oriente. The soil designated by the symbol CH produces 4 per cent of the sugar of Cuba. It includes mainly Chaparra clay with

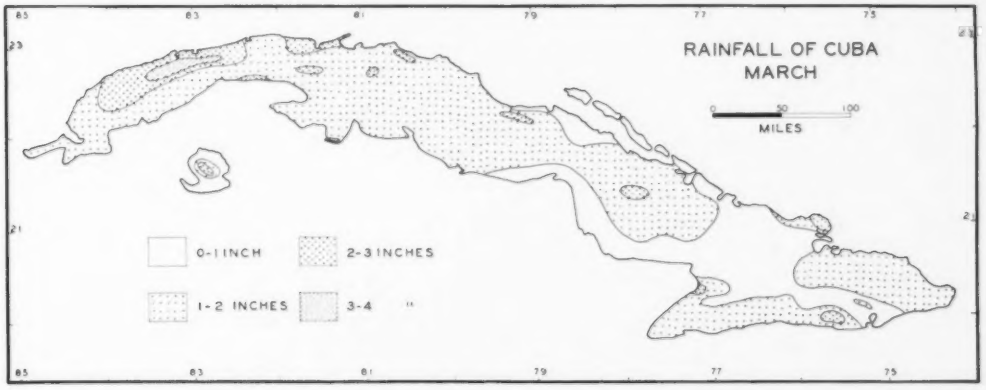


FIGURE 8.—The amount of rainfall which the month of March receives is quite similar to that of January for the island of Cuba as a whole. During March most of the island receives from one to two inches. Twenty-seven per cent of the sugar production is on land having less than one inch of rainfall, and 66 per cent on land having one to two inches of rainfall during this month. (Courtesy of Thomas W. Chamberlin.)

Habana clay and Alto Cedro clay each produce 8 per cent of the sugar of Cuba. Habana clay is most important in Habana, Santa Clara, and Oriente where it produces 14, 18, and 7 per cent of the sugar cane respectively. In Matanzas 2.61 per cent is grown on this type. There are some areas of Habana clay in Camaguey but they are of little importance in sugar production because of the prevalence of the relatively better soils of the MA and MC groups. The Alto Cedro clay, located principally in Oriente, includes chiefly Bayamo and Lugareno clays, with some Habana, Matanzas, and Francisco clays on the higher positions. About 7 per cent of some Lugareno and Francisco clay. It is most important in Oriente where it produces 13.4 per cent of the sugar of that province.

The remaining 30 per cent of the sugar of Cuba is grown on 22 other types of soil ranging from 3 per cent to a small fraction of 1 per cent of the total production. They are chiefly various types of clays. Thirteen types of soil shown on Figure 9 produce no sugar; they are NI, HO, GS, BS, OC, JU, GSL, NS, SA, PH, R, P, and SW.

Certain characteristics are common to the soils of Cuba. The predominant soils of Middle and Eastern Cuba are notably distinctive for their high clay

content, vast areas containing 75 per cent and some exceeding 90 per cent of clay particles. This clay content is of both the extremely friable and the extremely plastic kinds. The clay soils frequently absorb almost the entire rainfall and often show no visible change in color, texture, or structure from surface to the underlying rock. They often show a strong resistance to erosion. The red soils have gone through severe processes of weathering, including extreme leaching, and belong to the general group of soils known as laterites. At the other extreme there are large areas of clay soil which contain a high per cent of clay (often over 70 per cent) which are plastic and sticky when wet, but become very hard and shrink and crack badly when drying. Weathering has not proceeded as far as in the former group. There are many soils of intermediate characteristics between these two extremes. Other types of soils in Cuba include the sandy soils of the savannas and of western Cuba; residual soils formed by decay of the underlying schistose rock; swamp lands consisting of water-soaked clay covered with mangrove; and shallow stony soils of the mountainous areas.

Considering all the soils of Cuba, the Matanzas clays are best adapted to the production of sugar. They possess a number of remarkable characteristics such as marked physical and chemical uniformity from the surface to the underlying limestone; almost complete absorption of the liberal rainfall; and great depth of weathering. The topography is characteristically flat, and the color varies from light to dark red. These soils are loose, crack only slightly when drying, are sticky when wet but dry quickly and may be plowed within a few hours after rain. As the rainfall passes rapidly downward through the entire soil by percolation, there are few drainage ways, large tracts having none at all. Consequently, there is a distinct lack of erosion. The Santa Clara series, very important productive brown soils which are always underlain by limestone or chalk, crack more than the Matanzas clay but conserve moisture better. Considering the above soils, the characteristics of a good sugar soil seem to be good drainage, sufficient retention of moisture, subsoil aeration, lack of hardening and shrinking upon drying, friability, high content of lime and organic matter, ease of cultivation and productivity.

The remaining sugar producing soils are of intermediate character, containing patches of soils which are important in sugar production, but having considerable areas of soil not suited to the culture of sugar cane.

The sandy savanna soils (EM) can be farmed with heavy fertilization. The rough mountain land of Oriente produces some sugar on local areas of arable soil in the valleys and passes and on shouldering positions.

With the exception of the swamp lands and mountainous areas, the soils which produce no sugar cover only a small portion of the island. These soils have definite characteristics which make them unsuitable for the culture of sugar cane. They may be droughty or shallow, contain salty areas, have insufficient lime content, require ditching or deep knifing, contain stiff clays difficult to till effectively, have rough stony regions or limestone outcrops. The peat and swamp soils lack good drainage and are therefore unfavorable for sugar cane. One of the most important points to be considered in selecting an area for cane production is the adequacy of the surface and sub-surface drainage.

Relation of Sugar Production to Shape and Orientation of the Island:—Although the length of Cuba is 725 miles meas-

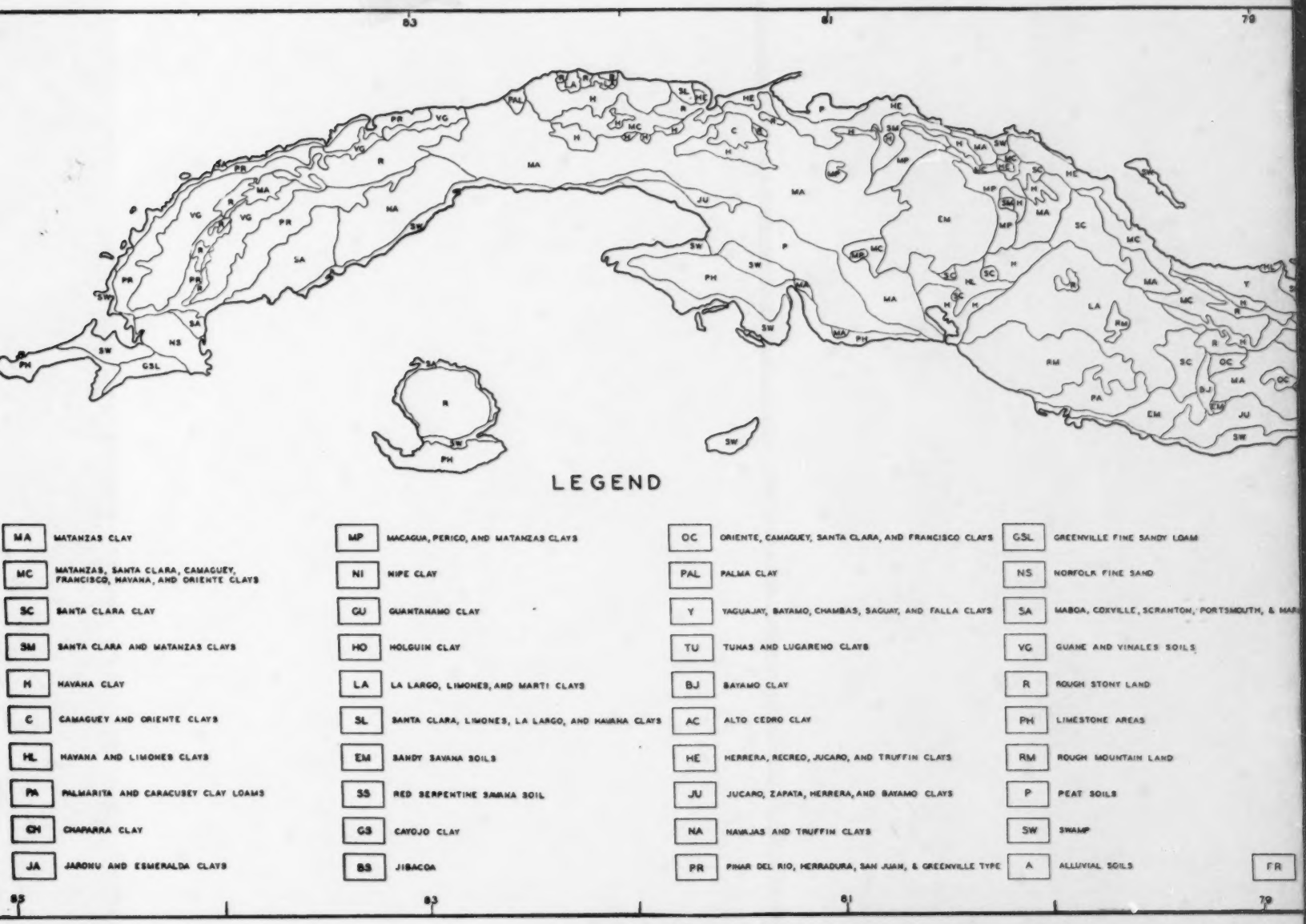

83
81
79
LEGEND
MA MATANZAS CLAY
MC MATANZAS, SANTA CLARA, CAMAGUEY, FRANCISCO, HAVANA, AND ORIENTE CLAYS
SC SANTA CLARA CLAY
SM SANTA CLARA AND MATANZAS CLAYS
H HAVANA CLAY
C CAMAGUEY AND ORIENTE CLAYS
HL HAVANA AND LIMONES CLAYS
PA PALMARITA AND CARACUSEY CLAY LOAMS
CH CHAPARRA CLAY
JA JAGUEY AND ESMERALDA CLAYS
MP MACAGUA, PERICO, AND MATANZAS CLAYS
NI NIPE CLAY
GU GUANTANAMO CLAY
HO HOLGUIN CLAY
LA LA LARGO, LIMONES, AND MARTI CLAYS
SL SANTA CLARA, LIMONES, LA LARGO, AND HAVANA CLAYS
EM SANDY SAVANA SOILS
SS RED SERPENTINE SAVANA SOIL
CG CAYOJO CLAY
BB JIBACOA
OC ORIENTE, CAMAGUEY, SANTA CLARA, AND FRANCISCO CLAYS
PAL PALMA CLAY
Y YAGUAJAY, BAYAMO, CHAMBAS, SAGUAY, AND FALLA CLAYS
TU TUNAS AND LUGARENO CLAYS
BJ BAYAMO CLAY
AC ALTO CEDRO CLAY
HE HERRERA, RECREO, JUCARO, AND TRUFFIN CLAYS
JU JUCARO, ZAPATA, HERRERA, AND BAYAMO CLAYS
NA NAVAJAS AND TRUFFIN CLAYS
PR PINAR DEL RIO, HERRADURA, SAN JUAN, & GREENVILLE TYPE
GSL GREENVILLE FINE SANDY LOAM
NS NORFOLK FINE SAND
SA MABOA, COXVILLE, SCRANTON, PORTSMOUTH, & MAR
VG GUANE AND VINALES SOILS
R ROUGH STONY LAND
PH LIMESTONE AREAS
RM ROUGH MOUNTAIN LAND
P PEAT SOILS
SW SWAMP
A ALLUVIAL SOILS
FR
83
81
79

FIGURE 9.—Though Cuba has a great variety of soil types, most of the sugar production of Cu have been derived from limestones formed during the Eocene-Oligocene period. Most of these s and fairly easily tilled. Six types or groups of soils produce 70 per cent of the Cuban sugar—see

oduction of Cuba is on not more than 24 types of soil. Most of these
Most of these soils are red to black clays of high fertility, well drained
an sugar—see Table VII. (After Bennett, H. H., and Allison, R. V.)

ured along an arc near the center of the island, the width varies from 24 miles just west of Habana to 82 miles in central Oriente. The long, narrow shape of the island places most of the sugar producing areas relatively near the sea. In few parts of the island does cane or sugar have to be transported more than 50 or 60 miles by rail. Other things being favorable this would allow for a general distribution of sugar cane production in most sections of the island. As the orientation is in a southeast-northwest direction, there is little horizontal zonation of climatic conditions. This direction gives most of the lowland areas more or less uniform temperature conditions, which also favors a general distribution of cane culture from near the western to the eastern end of the island. Tropical waters, surrounding the island, aid in giving Cuba marked uniformity of temperatures.

Relation of Harbors to Sugar Cane Distribution:—The coast line of Cuba, which is over 2000 miles in length, is remarkable for its large number of excellent harbors, roadsteads, and anchorages. Almost all of the harbors have a characteristic pouch shape, a narrow entrance opening into a broad bay. This pouch shape is illustrated by such harbors as those of Habana, Cienfuegos, Santiago, and Nuevitas.

The large number of available shipping points prompted many large firms and business combinations to build private ports for their own use, as it is convenient and profitable to export the sugar from nearby ports. However, a law promulgated in 1923, restricted the handling of foreign commerce to 26 first-class ports, with the proviso that the sugar centrals and other entities, which had constructed and used private ports prior to the enactment of the law, could continue to use them for the same purpose.

Due to the narrow width of the island no place in Cuba is more than 41 miles removed from the sea, so that no central is far removed from a port suitable for handling its export of sugar. The number, excellence and distribution of the harbors greatly facilitate the exportation of the enormous sugar crop thus preventing the congestion which would almost certainly ensue, if only a few ports were used. The large number of excellent harbors, rather evenly distributed along the coast, allows for a similar distribution of cane production in several parts of the island.

ECONOMIC FACTORS INFLUENCING THE PRESENT DISTRIBUTION OF SUGAR CANE PRODUCTION

Although of major significance in explaining the dominant position Cuba holds among the world sugar exporters, the economic factors play a comparatively minor rôle in determining the actual distribution of sugar cane within the island itself. There are, however, a few economic factors which are of sufficient significance to deserve brief analysis in their relation to the distribution of sugar culture.

The Early Start in the West:—For more than four centuries, sugar cane has been produced in Cuba. Much of the early production was confined to the north central portion of the island, especially in the provinces of Habana, Matanzas, and Santa Clara. Though the better soils of the low plains of these areas were inherently fertile, the long cultivation of sugar on the better lands without fertilization and rotation of crops and with the leaching of the soils finally led to the partial exhaustion of soil fertility and a consequent reduction of yields on the old sugar lands. Furthermore, as Habana, Matanzas, and other urban centers grew, some of the

land was diverted from sugar culture to dairying and fruit and vegetable production for the local markets. On the other hand the villages and towns that have grown up in connection with the centrals in the provinces of Habana, Matanzas, and Santa Clara tend to retain the importance of the sugar industries in these older areas.

After 1900, with the decline of the price of sugar in certain years, these older cane areas and the older centrals found it more and more difficult to compete with the newer cane lands and centrals of Camaguey and Oriente. Thus the early start in the west indirectly aided the recent shift of cane areas to portions of Camaguey and Oriente.

Transportation and the Distribution of Cane Production:—Transportation has been one of the chief factors in the development of the sugar industry as a whole and also in affecting the distribution in cane culture in different sections of the island. The centrals of Cuba are located to receive the inflow of cane from the fields. Their location with reference to the outgoing product is less important, for only about 15 per cent of the cane mass is transported away from the central. Also, the cane spoils within a few days after being cut and the cost of getting the cane to the mills is one of the large items of expense in the production of sugar. It is not profitable to haul the heavy cane by bullock cart for more than 5 miles.

The public railroads have also played an important part in developing the sugar industry to its present extent, and in the expansion of sugar culture into many inland areas, especially Camaguey and Oriente. They are dominated by two main systems—the Consolidated Railroad of Cuba, which controls rail transport in the eastern provinces and the United Railways which control rail transport in the west. The prosperity of Cuban railways has been largely a reflection of the growth of the sugar industry, as sugar has provided about 81 per cent of the total rail revenues. These methods of transportation are facilitated by the great area of level and rolling land in Cuba.

In only a few sections of the island do rugged relief or swampy areas hinder the development of rail transportation in sections which are especially well suited to sugar culture.

Population Density and Labor:—The low population density of Cuba and the consequent scarcity and high cost of labor compared to many other sugar producing areas, have been among the chief problems of the distribution of the industry in different parts of the island. In the very sparsely populated eastern provinces labor has always been relatively scarce and somewhat more expensive than in the older, more densely settled provinces of Habana, Matanzas and Santa Clara. However, in these provinces more opportunities for obtaining work have partially offset the advantage of more laborers. In those areas where a variety of activities are carried on some of the unemployed labor of the non-harvest season may be profitably employed at other tasks in times of slack work on the sugar plantations and in the centrals. For a long time the western provinces with the exception of Pinar del Rio have had a much greater variety of industry. Until recently the centrals in the eastern part of the island have regularly imported considerable numbers of laborers during the harvest season.

The Influence of Valorization on Distribution of Sugar Production:—More than ten years of valorization of Cuban sugar cane has had some considerable effects on the distribution of cane production, especially upon the closing

down of some of the older centrals and the taking over by more modern factories of the cane producing lands formerly served by these old centrals.

During more than a decade of low prices for sugar and of artificial restrictions, many old centrals, which had antiquated machinery and equipment, were forced out of business because they were among the high-cost producers (Figure 1). Some of the lands which supplied the old mills were closed permanently and the near-by sugar lands abandoned; this is particularly true of some of the centrals grinding cane from lands which might be classed as marginal because of sandy, stony, or partially exhausted soils or rather rough hilly areas. In the keen competition that resulted from low prices, artificial control, and labor troubles, the newer centrals of the east were somewhat favored over many of the older centrals of the west. However, in the rapid expansion of sugar culture into the eastern half of Cuba during the present century considerable areas of soils, not especially well suited to cane, declined very rapidly in yields and had to be abandoned. This accounts in a large measure for the closing down of some of the centrals of the eastern half of the island.

Influence of Land Tenure and Size of Holdings:—Cane is grown in Cuba by independent farmers, known as *colonos* and by the central corporations themselves. The *colono* system of farming, which is so important in the oldest cane areas of Cuba, tends to decentralize the production of sugar cane and to concentrate the manufacturing processes.

It tends to fix on the land independent cane farmers and also tends to retain production on smaller units in the well established sugar farming districts. In contrast to the *colono* system in the west, on many of the larger, newer sugar plantations in Camaguey and Oriente the land on which the cane is grown is often leased or owned outright by the corporation. Generally they raise cane with hired labor by themselves and lease other portions of the land under a contract system. The sparse rural population and large areas of virgin land in these eastern provinces favored the development of this system of farming. Furthermore this system lends itself particularly well to a greater degree of machine culture—a characteristic feature of some of the large and more modern plantations and centrals of Camaguey and Oriente.

In this attempt to analyze the distribution of sugar cane and to correlate the geographic and economic factors with this distribution, definite relationships appear. The economic factors as a group, while influencing the distribution of sugar culture in various ways are not as significant as most of the geographic factors. Thus the physical factors seem to be more distinctly related to the distribution of cane culture than the economic conditions. Of these factors, the influence of the soil on the distribution of the production of sugar cane is by far the most important.

ECONOMIC GEOGRAPHY

A QUARTERLY journal of economic geography published by Clark University for the benefit of geographers, economists, teachers, professional and business men, and all who are interested in the intelligent utilization of the world's resources.

Subscription rates are $5.00 the year in the United States and its Territories; $5.50 the year beyond the borders of the United States, except to charter subscribers.

The April issue of Volume 15 contains the following articles:

The Port of Bristol, F. Walker, University of Bristol, England.
Agriculture in Finland, William R. Mead, The London School of Economics and Political Science, London, England.
Land Tenure in the Leading Types of Farming of Puerto Rico, Rafael Picó, The Catholic University of America, Washington, D. C.
Granite Industry of Quincy, Massachusetts, J. Nelson Clifford, Bridgewater State Teachers College, Bridgewater, Massachusetts.
Climate and Agriculture in California, M. K. Bennett, Food Research Institute, Stanford University, California.
Geography of the Fiber-Flax Industry, People's International College, Elsinore, Denmark.
Land Forms, Settlement, and Land Utilization in the Southern Allgau, A. F. A. Mutton and A. E. Adams, University of London, England.
The Upper Thracian Plain in Bulgarian Agriculture, Anastas Beshkov, High School of Commerce, Svishtov, Bulgaria.
Block-Pile System of Statistical Maps, Erwin Raisz, Harvard University, Cambridge, Massachusetts.
The Pulque Industry, Raymond E. Crist, University of Illinois, Urbana.
Cacao Industry of Brazil, Elizabeth Keithan, Asheville Normal and Teachers College, Asheville, North Carolina.
United States Soybean Industry, George H. Primmer, State Teachers College, Duluth, Minnesota.

The January issue includes:

Field Observations on the Canton Delta of South China, Glenn T. Trewartha, The University of Wisconsin, Madison.
Population Studies in Three American Counties, Barnard Joy, U. S. Department of Agriculture, Washington, D. C.
The Aland Islands, Earl B. Shaw, State Teachers College, Worcester, Massachusetts.
Farm Distribution in Nova Scotia, D. F. Putnam, University of Toronto, Canada.
Pioneer Economy of Sakhalin Island, Herman R. Friis, The National Archives, Washington, D. C.
Silver Peak and Blair; Desert Mining Communities, John C. Weaver, The University of Wisconsin, Madison.
Foundations of Chinese Life, George B. Cressey, Syracuse University, Syracuse, New York.

The October issue of Volume 14 includes:

Panama Canal Traffic, Carol Y. Mason, Northwest Missouri State Teachers College, Maryville, Missouri, and Adagrace Rowlands, University of Wisconsin, Madison, Wisconsin.
Anthracite Region of Pennsylvania, Raymond E. Murphy and Marion Murphy, Pennsylvania State College, State College, Pennsylvania.
Isle Royale; Potential National Park, George H. Primmer, State Teachers College, Duluth, Minnesota.
Water Plan for the Great Valley of California, H. J. Wood, University of London King's College, England.
Cotton Regions of Mexico, Samuel N. Dicken, University of Minnesota, Minneapolis.
Norway's Industrialization, Claudia Thomson, United States Department of Agriculture, Washington, D. C.
Swine Industry of China, Earl B. Shaw, State Teachers College, Worcester, Massachusetts.
Mineral Wool Industry of the United States, William D. Thornbury, Indiana University, Bloomington, Indiana.
Blue Mountain Coffee of Jamaica, Harry E. Hoy, University of Illinois, Urbana, Illinois.
Some Recent Trends in Alaskan Commerce, Willis B. Merriam, Eastern Washington College of Education, Cheney.
Changing Frontier in the Columbia Basin, Albert L. Seeman, University of Washington, Seattle, and Harold E. Tennant, Wenatchee, Washington.

July includes:

Areal Distribution of Manufacturing in the United States, Clarence F. Jones, Clark University, Worcester, Massachusetts.
Tobacco Growing in Southwestern Ontario, Bert Hudgins, Wayne University, Detroit, Michigan.
Depletion in New England Fisheries, Edward A. Ackerman, Harvard University, Cambridge, Massachusetts.
Population Distribution in Newfoundland, Earl B. Shaw, State Teachers College, Worcester, Massachusetts.
Recreation Industry of New Hampshire, Albert S. Carlson, Dartmouth College, Hanover, New Hampshire.
Iron and Steel Industry of Scunthorpe, University of Bristol, Bristol, England.
Gypsum and Salt Mining in Central Hupeh, China, J. E. Spencer, Shanghai, China
Transportation in the Dominican Republic, William Van Royen, The University of Nebraska, Lincoln.
Communities in the Salt Lake Basin, Albert L. Seeman, University of Washington, Seattle.
Sugar Region of el Mante, W. A. Browne, East Carolina Teachers College, Greenville, North Carolina.

Single copies of back numbers of Volumes 1 to 5 inclusive will be sent to any American address for $1.75 each; to any foreign address for $2.00. Back numbers of Volumes 6 to 14 inclusive will be sent to any American address for $1.50 each; to any foreign address for $1.75. Whole volumes may be obtained at the yearly rate.

Send all subscriptions and orders to

ECONOMIC GEOGRAPHY,
Clark University, Worcester, Mass., U. S. A.